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PHYSICS ABSTRACTS

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SECTION A OF SCIENCE ABSTRACTS

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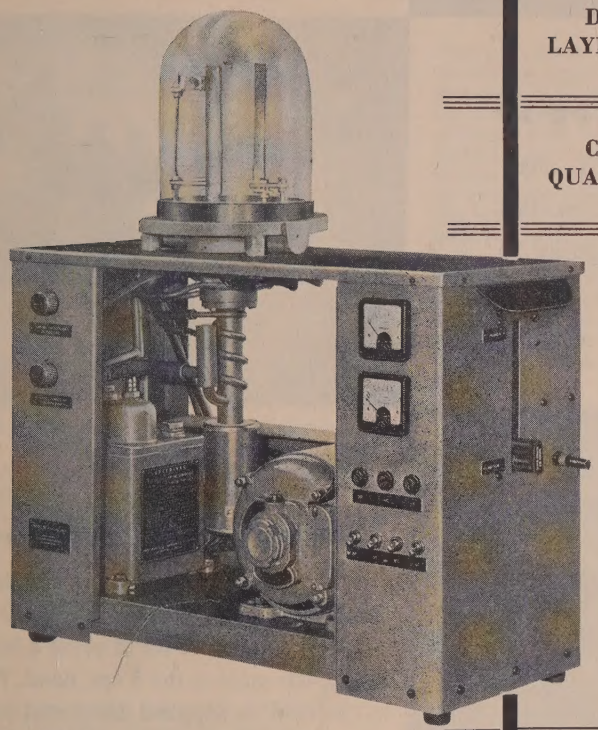

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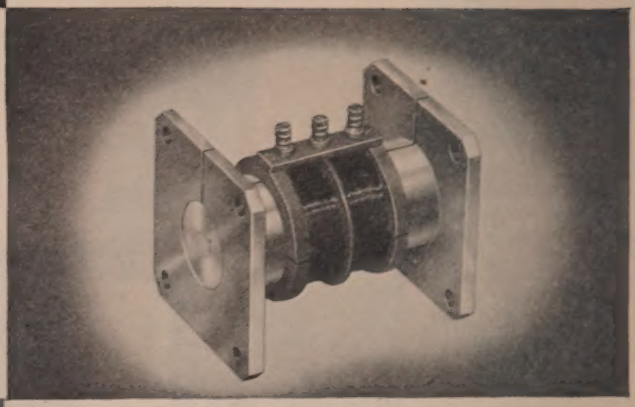

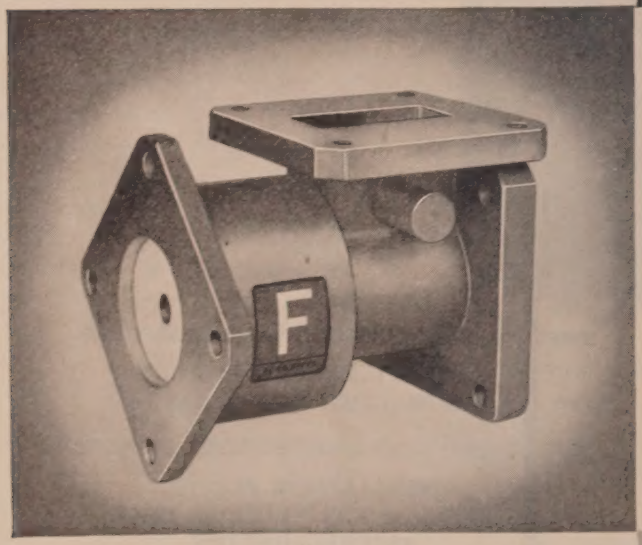

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PHYSICS ABSTRACTS

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MATHEMATICS

517.564 : 539.17

THE RATE OF CONVERGENCE OF THE SPHERICAL-ARMONICS METHOD FOR A SANDWICH REACTOR OF SMALL ATTICE PITCH. See Abstr. 8360

517.9

565. A CONVENIENT METHOD OF SOLVING LINEAR ROBLEMS INVOLVING COMPLEX NUMBERS.
Schmidtmayer and D.Mayer.
aboproudý Obzor, Vol. 19, No. 7, 472-7 (1958). In Czech.

Considers a system of m equations with n unknowns. The efficients of the equations and the unknowns are assumed to be mplex numbers. It is shown that the system can be described by 2m × 2n matrix consisting of real numbers. The procedure lopted in the solution of the system depends on whether the value the matrix is known (m = n) or unknown (m ≠ n). General solu-ons for m = n and m ≠ n are given and the method of computation illustrated by three numerical examples. It is pointed out that e method is especially suitable for solving the network equations means of electronic computers. R.S.Sidorowicz

518.4 : 519.25 : 539.12

566. ANALYTICAL REPRESENTATION OF ANGULAR DISTRI-UTION DATA. S.C.Snowdon, L.Eisenbud and J.F.Marshall.
appl. Phys., Vol. 29, No. 6, 950-3 (June, 1958).

A simple method is presented for obtaining an analytical curve fitted to data points. The requirements in least squares analysis that yield a single best curve are relaxed to the extent that it is only necessary to choose one of many possible good fits. The subsequent analytical determination of this good curve may be obtained with relatively little computational effort. Specifically, the method is applied to an analytical representation of angular distribution data by means of a Legendre polynomial series. A smooth curve which one feels is statistically justified is drawn through the data points. The values of this curve at eleven points are chosen as the coefficients in a Lagrange interpolation function series. The intermediate points give back approximately the drawn curve and are also statistically adequate. Subsequent use of a transformation matrix between the Lagrange interpolation basis and the Legendre polynomial basis yields the desired expansion. The transformation matrix is presented for the case in which an 11-point fit adequately characterizes the data curve. Error estimates also are given. A.

519.2 : 537.542 : 621.374.32

8567. METHODS FOR NUMERICAL CALCULATIONS WITH THE TYPE I COUNTER. P.G.Guest.
Austral. J. Phys., Vol. 11, No. 2, 143-53 (June, 1958).

Detailed schemes have been prepared for performing numerical calculations of frequency, expectation, and variance. Tables are given of the deviations of the asymptotic formulae from the exact formulae when the time of observation is small. A.

ASTRONOMY . ASTROPHYSICS

523.03

568. PROCEEDINGS OF THE THIRD SYMPOSIUM ON COSMICAL AS DYNAMICS. Edited by J.M.Burgers and R.N.Thomas.
ev. mod. Phys., Vol. 30, No. 3, 906-1108 (July, 1958).

This symposium was held at the Smithsonian Astrophysical bservatory, Cambridge, Massachusetts, June 24-29, 1957. Papers re grouped under the following headings: (1) Empirical studies of elocity fields in, and related structure of, the interstellar medium. (2) Theoretical considerations on the production and dissipation of elocity fields in the interstellar medium. (3) Cooling and condensa-on of interstellar matter. (4) Kinematic structure of gaseous envel-pes. Abstracts of the 43 individual papers will appear later.

523.112 : 530.12

A NEW INTERPRETATION OF THE PROJECTIVE THEORY F RELATIVITY AND APPLICATION TO A COSMOLOGICAL ODEL. See Abstr. 7675

523.74 : 537.591.5

POSSIBILITY OF FORECASTING SOLAR PHENOMENA AND HEIR EFFECTS AT THE EARTH BY THE STUDY OF COSMIC-AY INTENSITY. See Abstr. 8093

523.838

569. INVESTIGATIONS OF ROTATING STARS. II. FIRST-RDER THEORY. R.Kippenhahn.
. Astrophys., Vol. 46, No. 1, 26-65 (1958). In German.

Previous work (Abstr. 5645/1956) is extended to include terms the order of $\omega^2/2\pi G\bar{\rho}$, and the system of meridional circulation rrents is determined for a standard model star with an assumed n-rigid rotation. The effect of circulation currents on the rotation w is treated by a perturbation procedure, and, for slowly rotating ars, linearized equations are established. It is shown that the nearized first-order theory gives a limiting state of time-dependent rotation, independent of initial conditions, analogous to that established in the zero-order theory. Non-linear first-order equations are derived for more rapidly rotating stars, and the case for which $\omega r^2 \sin^2\vartheta$ is constant along a circulation stream line is considered. R.A.Newing

525.3 : 621.396.969.35 : 621.396.946

8570. SPUTNIK I'S LAST DAYS IN ORBIT.
J.D.Kraus and E.E.Dreese.
Proc. Inst. Radio Engrs, Vol. 46, No. 9, 1580-7 (Sept., 1958).

Observations made at the Ohio State University Radio Observatory, using a simple c.w. reflection technique are presented. The data suggest that the break-up of an artificial satellite upon its re-entry into the denser atmosphere is a complex phenomenon in which a sequential series of events may occur over a period of days. Graphs of the average height of the satellite and its associated fragments as a function of time are presented, and some conclusions are drawn as to the details of the actual break-up phenomenon. A.

529.786

8571. FREQUENCY OF CESIUM IN TERMS OF EPHEMERIS TIME. W.Markowitz, R.G.Hall, L.Essen and J.V.L.Parry.
Phys. Rev. Letters, Vol. 1, No. 3, 105-7 (Aug. 1, 1958).

The National Physical Laboratory, Teddington, and the U.S. Naval Observatory, Washington, have been co-operating since June 1955 to determine the frequency of the transition (4,0 − 3,0) in caesium. The result at zero magnetic field is

$$\nu_E = 9\,192\,631\,770 \pm 20 \text{ c/s of E.T. at 1957.0.}$$

A.H.Coo

PHYSICS

FUNDAMENTALS

530.12 : 530.145

8572. ON THE INVARIANCE PROPERTIES OF LAGRANGE FUNCTIONS FOR FIELDS. N.Mizkjewitsch.
Ann. Phys. (Leipzig), Folge 7, Vol. 1, No. 6-8, 319-33 (1958).
In German.

Invariance conditions are obtained for a scalar function $L(A_i;A_{i,\alpha};A_{i,\alpha\beta};g_{\mu\nu};g_{\mu\nu,\alpha};g_{\mu\nu,\alpha\beta})$, and conservation laws are derived without the introduction of integral expressions. The theory introduces automatically a relativistic generalization of angular momentum, and of other field quantities. The analytical form of L for gravitational and for electromagnetic fields is discussed.
R.A.Newing

530.12

8573. THE EQUATIONS OF MOTION OF UNIFIED FIELD THEORY IN THE LOWEST APPROXIMATION. J.Pachner.
Ann. Phys. (Leipzig), Folge 7, Vol. 1, No. 6-8, 351-8 (1958).
In German.

Equations of motion are obtained from field equations derived from a modified variation principle (Abstr. 8982/1957). Magnetic and electric fields are identified respectively with g_{ijk} and g_{ij4}. Equations obtained for the two-body problem include both Newtonian gravitational and Coulomb electrostatic forces. R.A.Newing

530.12

8574. RADIATION AND BOUNDARY CONDITIONS IN THE THEORY OF GRAVITATION. A.Trautman.
Bull. Acad. Polon. Sci. Sér. Sci. math. astron. phys., Vol. 6, No. 6, 407-12 (1958).

The connection between gravitational radiation and the boundary conditions imposed at infinity in general relativity are discussed and the radiation conditions so obtained are related to those formulated by Pirani (Abstr. 3944/1957) and Lichnerowicz (Abstr. 3674/1958). A method of evaluating the total radiated energy is given. G.Stephenson

530.12

8575. THE SECOND INVARIANCE IN VARIATIONAL RELATIVITY. J.M.Souriau.
C.R. Acad. Sci. (Paris), Vol. 246, No. 26, 3588-90 (June 30, 1958).
In French.

A new type of invariance introduced into the author's variational relativity (Abstr. 8972/1957) generalizes that introduced by Takabayasi (Abstr. 2774/1958) for the Dirac equation, and is interpreted in terms of the geometry of a fibre space. R.A.Newing

530.12

8576. HEISENBERG'S UNIVERSAL THEORY AND GRAVITATION. J.Rayski.
Nuovo Cimento, Vol. 9, No. 2, 337-9 (July 16, 1958).

The non-linear spinor field equation proposed by Heisenberg (Abstr. 2134/1958) is written in a generally covariant form so as to include gravitation. The metric tensor is assumed to depend on the co-ordinates x^k through two two-component spinors ψ and χ, and their hermitian conjugates such that

$$g^{ik} = \eta^{ik} + 2f^{ik} + f^{is}f^{k}{}_{s},$$

where

$$f^{ik} = l^6[(\psi^+\sigma^i\psi)(\chi^+\tau^k\chi) + (\psi^+\sigma^k\psi)(\chi^+\tau^i\chi)]$$

and η^{ik} is the metric tensor of flat space. The constant l has dimensions of a length and is identified with a dimensionless constant representing weak interactions in such a way that l^6 is approximately equal to the dimensionless gravitational coupling constant. Some consequences of this approach are briefly discussed
G.Stephenson

530.12 : 530.145

8577. QUANTUM LIMITATIONS OF THE MEASUREMENT OF SPACE–TIME DISTANCES. H.Salecker and E.P.Wigner.
Phys. Rev., Vol. 109, No. 2, 571-7 (Jan. 15, 1958).

This article deals with the limitations which the quantized nature of microscopic systems imposes on the possibility of measuring distances between space–time events. It is proposed to use only clocks for measuring space–time distances and to avoid the use of measuring rods which are essentially macrophysical objects. The accuracy of reading a clock with a given mass is considered and examples for microphysical clocks are given. It is shown that the mass of the clock, and the uncertainty (spread) of this quantity, exceed certain values which depend on the accuracy with which the time interval is to be measured, the magnitude of this time interval (the running time of the clock) and the size of the clock. The minimum mass uncertainty of the clock is given by Heisenberg's relation, the minimum mass itself is higher by the ratio of the running time and the accuracy. If the possibility of constructing states whose wave-functions are Gaussian wave packets is admitted, the mass and the mass uncertainty of the clock differs only by logarithmic factors from the uncertainties which follow from general principles of quantum mechanics. The masses are much higher if the possibility of constructing arbitrary wave packets is not admitted. A.

530.12 : 538.566

8578. EFFECT OF A GRAVITATIONAL FIELD, DUE TO A ROTATING BODY, ON THE PLANE OF POLARIZATION OF AN ELECTROMAGNETIC WAVE. N.L.Balazs.
Phys. Rev., Vol. 110, No. 1, 236-9 (April 1, 1958).

It is shown that for electromagnetic waves the gravitational field of a rotating body acts as an optically active medium. Thus, the plane of polarization of the wave rotates while it passes through this field. The effect is small. The angle of rotation due to the gravitational field of the sun is about 10^{-12} radian. A.

530.145

8579. QUANTUM MECHANICS AND GEOMETRY. I. M.Schönberg.
An. Acad. Brasil Ciênc., Vol. 29, No. 4, 473-99 (1957).

The paper is devoted to showing that the mathematics of quantum mechanics and field theory are of a geometric nature, and to developing the various kinds of geometric calculi needed for the purpose.
P.M.Davidson

530.145 : 539.12

8580. NOTE ON THE INTERACTION OF ELEMENTARY PARTICLES. J.Leite Lopes.
An. Acad. Brasil. Ciênc., Vol. 29, No. 4, 521-30 (1957).

Various weak interactions are considered. It is found that the μ–nucleon interaction cannot be explained simply by a direct π–μ–ν coupling, using static Chew theory for the π–nucleon coupling. Possible direct lepton–baryon couplings, with applications to lepton decay of strange particles, are also discussed. R.J.N.Phillips

530.145

8581. A NOTE ON STRONG COUPLING. L.M.Garrido.
An. Real Soc. Espan. Fís. Quím., Vol. 53(A), No. 11-12, 217-28 (Nov.-Dec., 1957). In Spanish.

An attempt to determine the fundamental state of the K-meson in interaction with pions in an interaction representation using a completely covariant formulation. L.Pincherle

530.145

8582. THEORY OF RELATIVISTIC-INVARIANT SPIN WAVE EQUATIONS. I-II. H.Donnert.
Acta. phys. Austriaca, Vol. 11, No. 3, 321-54, 355-76 (1957).
In German.

Possible linear wave equations for force-free particles of finite mass and half-integral spin are formulated under the most general possible assumptions; the only limitations imposed are invariance to the Lorentz transformation and the validity of the relativistic energy–momentum relation. P.M.Davidson

530.145

8583. RELATIVISTIC THEORY OF SPINNING POINT PARTICLES. J.Tiomno.
An. Acad. Brasil. Ciênc., Vol. 27, No. 3, 259-69 (1955).

The relativistic but unquantized theory of spinning particles is developed by starting from the non-relativistic theory, expressed by means of a variational principle, and modifying the variation integral so as to make it Lorentz invariant. The results are compared with those of Proca (Abstr. 5264/1954). The transition to quantum theory is performed, and it is found that for spin $\frac{1}{2}$ and 1 the Dirac and Yukawa equations are obtained. P.M.Davidson

530.145

8584. NOTE ON THE NON-RELATIVISTIC EQUATION FOR SPIN $\frac{1}{2}$ AND 1 PARTICLES WITH ANOMALOUS MAGNETIC MOMENT. J.J.Giambiagi.
An. Acad. Brasil. Ciênc., Vol. 27, No. 3, 271-7 (1955).

It is shown that if the relativistic wave-equations for particles

of spin $\frac{1}{2}$ and 1 are modified by adding a term representing an anomalous magnetic moment, and if the equations are then reduced to a non-relativistic approximation by the method of Foldy and Wouthuysen (Abstr. 5526/1950) the spin–orbit interaction term is given by the Thomas formula. P.M.Davidson

530.145

8585. ON THE ENERGY-MOMENTUM TENSOR OF DIRAC-LIKE FIELDS. H.G.Schöpf.
Ann. Phys. (Leipzig), Folge 7, Vol. 1, No. 1-3, 16-22 (1958). In German.

Considerations on the non-symmetry of the canonical tensor in field theory and that derived from Papapetrou's model of a spinning particle (Abstr. 703/1950). W.A.Hepner

530.145

8586. ON THE NONLINEAR THEORY OF ELEMENTARY PARTICLES. D.Ivanenko and A.Brodskiĭ.
Dokl. Akad. Nauk SSSR, Vol. 120, No. 5, 995-8 (1958). In Russian.

A Dirac spinor "matter field" is investigated, with the most general Fermi type nonlinear term without derivatives in the Lagrangian. Invariance under the proper Lorentz group and the Pauli group is demanded. To associate the Pauli group with isobaric rotations, a convenient 8-component spinor representation is used, corresponding to p, $\bar{n}$, n, $-\bar{p}$. The quantization is performed by retaining the usual three dimensional anticommutation relations. The non-vanishing invariants are determined and the field equation deduced. Then the variational equation for the Green's function is deduced by Schwinger's method. It turns out that in the absence of external fields the Green's function is equivalent to that for the linear field interacting with a boson vacuum of electromagnetic and mesonic type and with a field- and mechanical mass. In other words, the addition of nonlinear terms leads to an effective change of mass. Further, the boson field may be interpreted as the "liaison" of the primary spinor field. P.Roman

530.145

8587. REPRESENTATIONLESS FORMALISM IN THE FIELD THEORY OF FIXED NUCLEONS.
H.Ekstein, J.Swihart and K.Tanaka.
Phys. Rev., Vol. 109, No. 2, 557-66 (Jan. 15, 1958).

The usual approach to field theory, in which state vectors are expanded in terms of eigenvectors of H_0, is known to be inconsistent for point particles. An alternative method, in which only quantities bilinear in physical state vectors are considered, avoids this inconsistency. For the simplest case, the fixed point nucleon interacting with scalar charge-symmetric mesons, meaningful equations without infinite renormalization constants are obtained, and expansion in terms of the renormalized coupling constant f gives finite observables of one type. Observables "of the second kind", such as the interaction energy with an external field, cannot be defined as power series in f, but as limits of the quotients of two power series in f. The method is applied to the calculation of the magnetic nucleon moment in the static cutoff model with pseudovector coupling. Third and fifth approximations are calculated, and satisfactory convergence seems to prevail. The results are in agreement with experiments for the vector part of the moment, but the scalar part cannot be calculated on this model. A.

530.145 : 539.14

8588. STRUCTURE OF THE NUCLEON.
J.Bernstein and M.L.Goldberger.
Rev. mod. Phys., Vol. 30, No. 2(I), 465-70 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). The nucleon charge and magnetization density functions are discussed in terms of pion field theory, using dispersion relations. It seems possible to understand the isotopic vector parts of these functions semi-quantitatively; the isotopic scalar parts are thought to come largely from three-pion virtual processes, not at present amenable to calculation. R.J.N.Phillips

530.145

8589. ON THE RELATIVISTIC PHASE-SHIFTS OF PARTIAL WAVES IN A STATIC THOMAS–FERMI SCATTERING FIELD.
T.Gajewski.
Ann. Phys. (Leipzig), Folge 7, Vol. 1, No. 4-5, 299-304 (1958). In German.

It is shown that Henneberg's non-relativistic formula for the phase-shifts in terms of the potential (Abstr. 4255/1933) can easily be modified for the case of the relativistic Schrödinger equation. The resulting phase-shifts for uranium, at 40 keV, are compared with the non-relativistic ones (Abstr. 7420/1958) and with the results of a numerical calculation (Abstr. 523/1954). W.A.Hepner

530.145

8590. DISPERSION RELATIONS FOR SCATTERING IN THE PRESENCE OF A COULOMB FIELD. G.F.Chew and H.P.Noyes.
Phys. Rev., Vol. 109, No. 2, 566-70 (Jan. 15, 1958).

A dispersion relation is derived for short-range potential scattering in the presence of a Coulomb field, and on the basis of this result a conjecture is made as to the Coulomb modifications of the Goldberger (Abstr. 8509/1955) relations for pion–nucleon scattering. The new relations contain in addition to Coulomb phase-shifts only amplitudes that are directly measurable experimentally, the assumption of charge independence not being required. Estimates are made to show that the Coulomb phases that appear explicitly are of not practical importance. A.

530.145

8591. APPLICATION OF DISPERSION RELATIONS TO NEUTRON–ELECTRON INTERACTION. K.Tanaka.
Phys. Rev., Vol. 109, No. 2, 578-84 (Jan. 15, 1958).

The main part of the neutron–electron interaction is accounted for by the Foldy term of 4.08 keV (Abstr. 7534/1951, 7947-8/1952). The most recent experimental value is 4.165 keV. The static charge-cloud term obtained in Chew's no-recoil theory (Abstr. 10807/1954, 2680-1/1956) which does not include the Foldy term, therefore, should contribute an interaction of a few hundred eV, whereas Salzman's calculation (Abstr. 8508/1955) corresponding to $f^2 = 0.08$ would give ~ 10 keV, which is in serious disagreement with experiment. Treiman and Sachs (Abstr. 6363/1956) found that the higher order corrections in the static model reduce the discrepancy by about 20%. The present author carries out a covariant calculation of the meson current part of the neutron–electron interaction, using dispersion relations derived by Chew et al. under the assumption that the (3,3) resonance dominates the dispersion integral. It is found that the recoil effects of the perturbation part reduce Salzman's perturbation result by 30%, and the higher order corrections including recoil reduce the perturbation result further by about 20%. The final result is 5.7 keV for $f^2 = 0.08$. The contribution of the meson current to the anomalous magnetic moment of the nucleon is found to be 2.9 nuclear magnetons for $f^2 = 0.08$. A.

530.145

8592. COMPLETE SET OF DISPERSION RELATIONS FOR A CLASS OF FIXED-SOURCE MESON THEORIES.
R.E.Norton and A.Klein.
Phys. Rev., Vol. 109, No. 2, 584-600 (Jan. 15, 1958).

The structure of the transition matrices for all processes that can occur for a class of fixed-source meson theories is studied. The model consists of a scalar meson field coupled to an extended source in such a way that any finite number of quanta can be emitted or absorbed at a given time (multiple vertices), but that all interactions are restricted to be S-wave in nature. The general reaction matrix element for m incident and n emergent particles contains many terms describing sequences of independent processes, which must be removed before one obtains a proper object for studies of a dispersion-theoretic nature. It is shown that the ratio of the residual matrix element to a suitable product of source functions possesses those analytic properties, as a function of the total energy of the system, which permit dispersion relations to be stated. Other than for the elastic scattering amplitude the latter make reference to values of the amplitude in a nonphysical energy region. In conjunction with a suitably generalized unitarity condition, however, the scheme, when viewed as a set of coupled integral equations, can be solved by successive approximations in terms of a number of arbitrary constants, essentially equal to the number of coupling constants in the original Hamiltonian (actually one fewer). Nevertheless, it is pointed out that the scheme does not admit a unique solution, and this is illustrated physically by exhibiting an extended class of Hamiltonians which yield the same dispersion relations, but which, as a class, contain more coupling constants than make their appearance in the dispersion relations. Physically, these are connected with the occurrence of resonance scattering. A.

530.145 : 539.12

π^- SCATTERING AND DISPERSION RELATIONS. See Abstr. 8990

530.145

8593. A KINEMATICAL TEST FOR THE RELATION BETWEEN THE COUPLING CONSTANTS IN MESON THEORY. K.Hiida.
Progr. theor. Phys., Vol. 17, No. 4, 605-7 (April, 1957).

It is claimed that in S(S) and PS(PS) theories, the relation between the renormalized and unrenormalized coupling constants ob-

tained by the method of Landau (see Abstr. 7258/1958) cannot coincide with that obtained by perturbation calculations.

P.K.Kabir

530.145 : 539.12

K-MESON CONTRIBUTION TO FORCES BETWEEN BARYONS. See Abstr. 8247

530.145

8594. GREEN'S FUNCTIONS IN MESON THEORIES.
A.A.Abrikosov, A.D.Galanin, B.L.Joffe, I.Ya.Pomerančuk and I.M.Halatnikov.
Nuovo Cimento, Vol. 8, No. 5, 782 (June 1, 1958).

An error is pointed out in Hiida's recent works (see preceding abstract) which claims that the results of the present authors do not agree with calculations based on perturbation theory. The source of the error in Hiida's work is shown to be connected with an improper handling of mass renormalization. P.Roman

530.145 : 539.19

8595. CHARACTERISTIC EXPONENT FOR THE RADIAL WAVE EQUATION WITH A MAXWELLIAN POTENTIAL.
E.Drauglis and B.Widom.
J. chem. Phys., Vol. 28, No. 2, 309-10 (Feb., 1958).

The radial Schrödinger equation with a repulsive R^{-4} potential energy is equivalent to a Mathieu equation, and the associated characteristic exponent is an important parameter in determining the properties of the solution. The characteristic exponent is tabulated for the six lowest angular momentum states and for a range of energies of interest in molecular dynamics. A.

530.145 : 539.18

8596. CONSOLIDATED VARIATION PERTURBATION THEORY.
H.Shull and W.T.Simpson.
J. chem. Phys., Vol. 28, No. 5, 925-8 (May, 1958).

A formula is derived which gives the exact remainder to the approximate energy eigenvalue obtained by the variation method. The remainder formula and approximations to it are closely related to the usual second-order perturbation formula. A scheme is suggested for consolidating the linear variation method and remainder formula into a single approximation method for energy eigenvalues. The method is illustrated with a calculation of the energy of the ground state of helium using 136 basis functions. A.

530.145 : 533.6 : 536.7 : 532.5

SOME ASPECTS OF DIABATIC FLOW AND GENERAL INTERPRETATION OF THE WAVE MECHANICS FUNDAMENTAL EQUATION. See Abstr. 7731

530.145 : 530.12

QUANTUM LIMITATIONS OF THE MEASUREMENT OF SPACE–TIME DISTANCES. See Abstr. 8577

530.16

8597. RELAXATION OF THE STRING OSCILLATOR. B.Widom.
J. chem. Phys., Vol. 28, No. 5, 918-25 (May, 1958).

As was pointed out by Herzfeld, a single collision between an oscillator and an impinging particle usually consists of a multiplicity of impacts. If the oscillator is a particle on an inextensible string (mechanically equivalent to a particle in a box), and if it interacts impulsively with particles of identical mass incident along its line of oscillation, then each collision either consists of a single impact, in which case momentum is exchanged, or of a double impact, in which case there is no net momentum exchange. The transition probability is calculated exactly, and the resulting integro-differential equation for the oscillator distribution function is solved explicitly. It is shown that the approach to equilibrium is not in general exponential in the time, even in its last stages, but that it may be made so with a special initial distribution. The effect of impact multiplicity on the time of relaxation is discussed. A.

530.162 : 541.124

8598. MEAN FIRST PASSAGE TIME FOR A RANDOM WALKER AND ITS APPLICATION TO CHEMICAL KINETICS.
Shoon Kyung Kim.
J. chem. Phys., Vol. 28, No. 6, 1057-67 (June, 1958).

The mean first passage time for a random walk with reflecting and absorbing barriers is computed by assuming Onsager's reciprocal relation for the transition probabilities. The result, which is valid for an arbitrary dimensional random walk, appears as a quotient of determinants whose elements are the transition probabilities and the initial distribution. For the one-dimensional case, this result is written as a series which converges rapidly when nearest neighbour transitions predominate; in fact, the series reduces to a closed form for the case when only nearest neighbour transitions are allowed, and always converges for the case when only nearest and next-nearest transitions are allowed. Montroll and Shuler's computation of the mean first passage time for the case of the truncated harmonic oscillator model of a diatomic molecule is simplified and extended to an arbitrary initial distribution. In addition, the mean first passage time for the case of an harmonic oscillator model is computed by using the transition probability obtained recently by Shuler, Bazley, and Montroll. In terms of the mean first passage time, the range of validity of the equilibrium theory in chemical kinetics is discussed. A.

530.162

8599. A DIELECTRIC FORMULATION OF THE MANY BODY PROBLEM: APPLICATION TO THE FREE ELECTRON GAS.
P.Nozières and D.Pines.
Nuovo Cimento, Vol. 9, No. 3, 470-90 (Aug. 1, 1958).

Under suitable conditions it is shown that a generalized dielectric constant $\epsilon(k, \Omega)$ for an arbitrary many-body problem may be defined by analogy with the macroscopic laws of electrostatics. The ground state energy may then be simply expressed in terms of $\epsilon(k, \Omega)$ without resort to perturbation theoretic expansions. Within the random phase approximation (RPA), $\epsilon(k, \Omega) = 1 + 4\pi\alpha(k, \Omega)$, where $\alpha(k, \Omega)$ is the complex polarizability obtained by a generalized Kramers–Heisenberg formula in the plane-wave representation. For the free electron gas, this value of $\epsilon(k, \Omega)$ leads directly to the expression for the ground state energy obtained by Gell-Mann and Brueckner and by Hubbard in the high density limit. It is shown that the treatment of electron interaction within the RPA is equivalent to taking into account only the field of surface charges at the external boundary of the system; it thus corresponds to neglecting all potential and local field corrections. $\epsilon(k, \Omega)$ may be inferred from the inelastic scattering of fast electrons or from the Compton scattering of X-rays; the circumstances are discussed under which such experiments yield information about the ground state energy of the electron gas. A.

530.162 : 532.7 : 533.7

8600. NODAL EXPANSIONS. II. THE GENERAL EXPANSION OF N-TH ORDER. E.Meeron and E.R.Rodemich.
Phys. of Fluids, Vol. 1, No. 3, 246-50 (May-June, 1958).

For Pt I, see Abstr. 2820 (1958). The first-order nodal expansion of potentials of average force and distribution functions, obtained in the previous paper, is summed over again and converted into a second-order expansion. The method is generalized, and recursion formulae are given for n-th order expansions of potentials of average force in terms of "sheaf potentials". These latter are seen to conform exactly to the Kirkwood superposition principle. The feasibility of actual calculations is briefly discussed. Possible applicability to quantum-mechanical problems (Feynman diagrams) is noted. A.

530.162 : 536.7

8601. AN EXTREME PROPERTY OF THE FREE ENERGY.
H.Koppe.
Z. Phys., Vol. 150, No. 1, 64-6 (1958). In German.

It is shown quite generally that a lower limit of the sum-over-states exists, by comparing sums whose arguments are respectively eigenvalues of a Hermitian operator and arbitrary linear combinations of them. The condition is deduced that the derivative of the sum is a monotonically increasing function in the region of the eigenvalues. As examples, it is shown that the vibrational energy of a crystal is subject to this inequality, while the corresponding specific heat is not. P.Gray

530.162

8602. ON THE ERGODIC THEOREM AND ON THE CONCEPT OF MACROSCOPIC OBSERVABLES. I. G.Ludwig.
Z. Phys., Vol. 150, No. 3, 346-74 (1958). In German.

An attempt is made to exhibit ergodic behaviour as a property of the physical system rather than as dependent on the sort of observations made. The system is characterized by a Hilbert space, a Hamiltonian operator, and a decomposition of the space into subspaces corresponding to the number of particles in the system. Ergodic observables and integrals of motion are discussed in detail from the new standpoint and the results are compared with von Neumann's approach to the ergodic theorem in quantum mechanics. R.A.Newing

530.162

8603. ON THE ERGODIC THEOREM AND ON THE CONCEPT OF MACROSCOPIC OBSERVABLES. II. G.Ludwig.
Z. Phys., Vol. 152, No. 1, 98-115 (1958). In German.

Continuing previous work (see preceding abstract), detailed

consideration is given to the definition of macroscopic observables, and, as an illustration, it is shown that the proposed definition leads automatically to the choice of position and momentum of the mass centre as quantum mechanical macroparameters in the case of a one-dimensional rigid body composed of N identical particles. It is also shown that the entropy of a system can be introduced as a macroscopic observable. The ergodic behaviour of macroscopic observables is discussed, and a condition for ergodic systems is given.
R.A.Newing

530.162 : 541.127

BROWNIAN MOTION AND CHEMICAL KINETICS. See Abstr. 8499

530.19

INVARIANT IMBEDDING RELATION FOR THE PRINCIPLES OF INVARIANCE. See Abstr. 7436

530.19 : 539.166.07 : 539.12

GAMMA-RAY COLLIMATOR PENETRATION AND SCATTERING EFFECTS. See Abstr. 8962

GENERAL MECHANICS. MECHANICS OF SOLIDS

531.571

8604. APPLICATION OF RADIOACTIVE TRACERS TO THE STUDY OF SHAPED CHARGE PHENOMENA.
G.M.Bryan, R.J.Eichelberger, D.MacDonald and P.E.Zigman.
J. appl. Phys., Vol. 28, No. 10, 1152-5 (Oct., 1957).

The problem of determining the velocity of a given element in a shaped charge jet as a function of the position of that element in the parent liner has been attacked with the help of radioactive tracers. Radioactively tagged liners were fired into stacks of steel plates, and the depth reached by the tagged element in each case was determined by radioactive assay of the plates. The resulting depth v. position curve was combined with emergent jet velocity data to yield velocity as a function of position. The results are in rough qualitative agreement with those previously obtained by the somewhat unwieldy method of collecting and weighing jets and slugs. The radioactive method is more direct and appears to be capable of sufficient refinement to warrant its use as a research tool. A.

531.577

8605. STUDIES OF HIGH-VELOCITY IMPACT IN WAX.
W.S.Partridge and W.G.Clay.
J. appl. Phys., Vol. 29, No. 6, 939-42 (June, 1958).

Penetration of wax pellets into wax targets was found to vary linearly with the cube root of the pellet mass and the pellet velocity up to velocities in excess of twice the sonic velocity in the wax target. The crater area varies directly as the impact velocity, but there is a marked increase in the constant of proportionality above the target sonic velocity. The volume of the crater per unit energy of the pellet was found to be 2.23×10^{-8} m^3/J for the lower velocity range and above the target sonic velocity the value was found to be 2.75×10^{-8} m^3/J. It was observed that a large part of the crater volume is created by deformation of the target material and that only a small part is due to ejection of the target material. A.

MECHANICAL MEASUREMENTS

531.787.9 : 621.317.39

8606. SMALL BARIUM TITANATE TRANSDUCER FOR AERODYNAMIC OR ACOUSTIC PRESSURE MEASUREMENTS.
W.W.Willmarth.
Rev. sci. Instrum., Vol. 29, No. 3, 218-22 (March, 1958).

The design, development, and calibration of a small barium titanate pressure transducer for aerodynamic or acoustic pressure measurements are described. The calibration was carried out in a shock tube. A few typical oscilloscope records of the transducer response to shock waves are shown. From the calibration, it was found that the transducer response is uniform from approximately 5 to 50 000 c/s and the sensitivity of the transducer is 0.88×10^{-6} V dyn^{-1} cm^{-2}. A.

MECHANICS OF FLUIDS

532.13 : 539.374

VISCO-ELASTIC PROPERTIES OF CONCENTRATED POLYMER SOLUTIONS. See Abstr. 8488

532.13 : 534.23

VOLUME VISCOSITY OF ASSOCIATED LIQUIDS. See Abstr. 8648

532.511 : 541.124

8607. HYDRODYNAMICS OF A REACTING AND RELAXING FLUID. R.M.Mazo and J.E.Mayer.
J. appl. Phys., Vol. 29, No. 4, 735-6 (April, 1958).

The authors estimate the validity of Kirkwood and Wood's (Abstr. 5909/1957) rate equation for a system in which a chemical reaction is in progress, assuming that the equation would be valid at fixed composition. They show that the use of this rate equation is restricted to reactions with relaxation times of 1 msec or slower. There is the further assumption made that the excess energy is equivalent to the heat of reaction per molecule. It may, however, be considerably less. A more detailed analysis of intermolecular energy transfer is necessary, if the excess energy is not rapidly redistributed among a specific class of degrees of freedom.
R.Schnurmann

532.517

8608. SHEAR RATE DEPENDENCE OF THE VISCOSITY AND ELASTIC COMPLIANCE OF POLYMER MELTS — CORRESPONDENCE WITH A HYDRODYNAMIC THEORY OF VISCOELASTIC FLOW. R.H.Boyd.
J. appl. Phys., Vol. 29, No. 6, 953-6 (June, 1958).

The variation of viscosity and elastic compliance with shear rate of several typical polymer melts was measured. The results are compared with the predictions of a hydrodynamic flow theory proposed by Pao (Abstr. 64/1958). The agreement is satisfactory.
A.

532.517.2

8609. LAMINAR FLOW IN AN ANNULUS WITH POROUS WALLS.
A.S.Berman.
J. appl. Phys., Vol. 29, No. 1, 71-5 (Jan., 1958).

When certain restrictions are applied to the radial component of flow it is possible to obtain an exact solution to the Navier–Stokes equations describing the steady-state flow of an incompressible fluid in an annulus having porous walls. The effects of such restricted radial flows on the characteristics of the flow field have been examined. A.

532.529.7 : 536.423.4

8610. CONDENSATION INTERFACES IN TWO-PHASE FLOWS.
P.Chiarulli and R.F.Dressler.
J. appl. Phys., Vol. 28, No. 9, 990-7 (Sept., 1957).

The condensation zone of a condensing vapour flowing in a channel is idealized as an interface separating vapour and liquid phases of the fluid with a concentrated friction, heat removal, and cold liquid injector mechanism at the interface. Rankine–Hugoniot relations are obtained including effects of the mass, momentum, and energy sources at the interface. For a stationary interface, an explicit approximate solution is obtained giving the final liquid state in terms of the other parameters. In addition, a rapidly converging iterative procedure is presented with this solution as a first approximation and utilizing directly thermodynamic tables of the vapour and liquid. Examples corresponding to steam flow in a pipe and to an underwater steam jet are considered and their Hugoniot curves are computed and compared to similar curves obtained in detonation theory. The thermodynamic requirements of the existence of a steam–water interface limit these curves in extent and result in upper and lower bounds on the values of the cooling parameters.
A.

532.612.4 : 536.423.1

THE TEMPERATURE DEPENDENCE OF SURFACE TENSION. See Abstr. 8730

532.613.4 : 535.81 : 778.31

8611. MICROCINEMATOGRAPHY OF DYNACTIVE PAIRS OF FLUIDS. A.Krings.
Z. wiss. Mikr., Vol. 63, No. 7, 391-6 (March, 1958). In German.

Dynactive liquids A and B are miscible and are such that B is denser than A, but A has a greater surface tension than B. They

form vortices at a liquid junction. A conventional schlieren system with colour contrast was used for observing the effects.

W.T.Welford

532.63 : 539.217

VOLUMES AND SURFACE AREAS OF PENDULAR RINGS. See Abstr. 9131

MOLECULAR THEORY OF LIQUIDS

532.7 : 532.61

8612. FREE ENERGY OF A NONUNIFORM SYSTEM. I. INTERFACIAL FREE ENERGY. J.W.Cahn and J.E.Hilliard.
J. chem. Phys., Vol. 28, No. 2, 258-67 (Feb., 1958).

It is shown that the free energy of a volume V of an isotropic system of nonuniform composition or density is given by: $N_V \int_V [f_0(c) + \kappa(\nabla c)^2] dV$, where N_V is the number of molecules per unit volume, ∇c the composition or density gradient, f_0 the free energy per molecule of a homogeneous system, and κ a parameter which, in general, may be dependent on c and temperature, but for a regular solution is a constant which can be evaluated. This expression is used to determine the properties of a flat interface between two coexisting phases. In particular, it is found that the thickness of the interface increases with increasing temperature and becomes infinite at the critical temperature T_C, and that at a temperature T just below T_C the interfacial free energy σ is proportional to $(T_C - T)^{3/2}$. The predicted interfacial free energy and its temperature dependence are found to be in agreement with existing experimental data. The possibility of using optical measurements of the interface thickness to provide an additional check of the treatment is briefly discussed. A.

532.7

8613. OVERHAUSER EFFECT IN MANGANESE SOLUTIONS IN LOW MAGNETIC FIELDS. R.S.Codrington and N.Bloembergen.
J. chem. Phys., Vol. 29, No. 3, 600-4 (Sept., 1958).

The sign of the Overhauser effect for protons in Mn^{++} aqueous solutions in external fields between 5 and 20 gauss is such, that the dominant relaxation mechanism is scalar coupling between the protons and electron spins. The electronic $\Delta F = 0$, $\Delta m_F = \pm 1$ transitions in the hyperfine multiplet were saturated and the enhancement of the proton resonance signal with increasing electronic saturation was observed up to a factor of about 300 times. The dependence of the proton and electron relaxation times on external field agree well with a theory which takes due account of the hyperfine multiplet in the Mn^{++} ion. A.

532.7

8614. STRUCTURE OF LIQUID GERMANIUM DIOXIDE.
J.D.Mackenzie.
J. chem. Phys., Vol. 29, No. 3, 605-7 (Sept., 1958).

Viscosity and electric conductivity measurements were made on liquid germanium dioxide over the temperature range 1250-1550°C. The relationship between log viscosity and 1/T is not linear and the energy and entropy of activation for viscous flow decreases with increasing temperature. Electric conduction obeys the empirical Arrhenius relationship, the energy of activation for conduction being 46.5 kcal/mole. From electronegativity considerations the energy of the Ge—O bond is estimated to be 104 ± 8 kcal. Liquid GeO_2, similar to liquid SiO_2, is highly associated, the classical network structure for solid glasses being applicable. A mechanism for viscous flow is postulated. A.

532.7 : 539.14

8615. NUCLEAR MAGNETIC RELAXATION OF THREE AND FOUR SPIN MOLECULES IN A LIQUID. P.S.Hubbard.
Phys. Rev., Vol. 109, No. 4, 1153-8 (Feb. 15, 1958).

The semiclassical density-matrix theory of relaxation is employed to calculate the relaxation of the z-component of nuclear magnetization of molecules in a liquid for the cases in which the molecules contain either three or four equidistant identical nuclei of spin ½ arranged, respectively, at the corners of an equilateral triangle or a tetrahedron. The relaxation is assumed to be due to the time dependence of the intramolecular dipole–dipole interactions that result from the classical rotational diffusion of the molecules. It is found that, if the initial state of the spin systems is characterized by a spin temperature, the relaxation consists of the sum of two terms which decay exponentially with different time constants. A.

532.7 : 539.2

NUCLEAR MAGNETIC RESONANCE OF MOLTEN AND SOLID THALLIUM SALTS. See Abstr. 9127

532.7 : 533.7 : 530.162

NODAL EXPANSIONS OF POTENTIALS OF AVERAGE FORCE AND DISTRIBUTION FUNCTIONS. GENERAL EXPANSION OF N-TH ORDER. See Abstr. 8600

532.7 : 537.56

QUANTUM STATISTICAL THEORY OF PLASMAS AND LIQUID METALS. See Abstr. 8829

532.73

8616. STRUCTURE IN IONIC SOLUTIONS. II. G.W.Brady.
J. chem. Phys., Vol. 28, No. 3, 464-9 (March, 1958).

For Pt I, see Abstr. 9565 (1957). The diffraction patterns of concentrated KOH and LiCl solutions have been analysed. The results indicate that the hydration number for the OH^- ion is 6. Previous work on less concentrated KOH solutions had indicated a hydration number of 4 for the K^+ ion and a substitutional entry of the cation into the water lattice. The present work agrees with these findings. The dissolution process in LiCl appears to be of a different nature, in that there is a breakdown of the water structure, probably caused by the Li^+ ion. The water molecules and the hydrated Li^+ ions then pack around the large Cl^- ion to give an apparent hydration member for Cl^- of 8-9. A.

532.77 : 541.127

8617. THEORY OF SOLUTIONS AND THE REACTION KINETICS IN NUCLEOPHILIC SUBSTITUTION. C.R.Mueller.
J. chem. Phys., Vol. 28, No. 5, 846-50 (May, 1958).

The statistical mechanical theory of solutions is applied to reaction kinetics and the effect on reaction order is calculated. It is found that the rate constant is multiplied by an exponential function of the concentration of addend, solvent, product, or reactant. The theory is then applied to data obtained by Ingold and others from studies of nucleophilic substitution on saturated carbon atoms. The exponential dependence predicted by theory is observed. A.

532.77 : 539.19

8618. THEORY OF THE ONE-DIMENSIONAL PHASE TRANSITION IN POLYPEPTIDE CHAINS.
B.H.Zimm and J.K.Bragg.
J. chem. Phys., Vol. 28, No. 6, 1246-7 (June, 1958).

It has been found that polypeptide chains in solution can be converted reversibly from the randomly coiled form to the α-helix form over a relatively narrow temperature range of about 10°. This change can be regarded as a diffuse phase transition of the first order in one dimension. The authors provide a model which enables them to use the matrix method of dealing with one-dimensional cooperative assemblies. A reasonably "sharp" transition is obtained which is explained physically by noting that the formation of the first turn of the helix requires a substantial loss of entropy but that, once achieved, it acts as a nucleus for the remaining part of the transition. It is pointed out that the process under discussion does not violate the well known theorem which says that first order, one-dimensional phase changes are impossible. See also the abstract following.

R.O.Davies

532.77 : 539.19

8619. THEORY OF HELIX-COIL TRANSITIONS IN POLYPEPTIDES. J.H.Gibbs and E.A.DiMarzio.
J. chem. Phys., Vol. 28, No. 6, 1247-8 (June, 1958).

A treatment of the problem of the preceding abstract which is at once more concrete and less elegant. The authors make reasonable assumptions about the behaviour of the hydrogen bonding along the chain and then write down a configurational partition function for system, which they discuss qualitatively. The limiting behaviour seems to be reasonable but intermediate results await machine computation. R.O.Davies

532.77

8620. THEORY OF DILUTE POLYMER SOLUTION. II. OSMOTIC PRESSURE AND FRICTIONAL PROPERTIES.
M.Kurata and H.Yamakawa.
J. chem. Phys., Vol. 29, No. 2, 311-25 (Aug., 1958).

For Pt I see Abstr. 3775 (1958). The osmotic second virial coefficient of flexible polymer solutions is calculated on the basis of the pearl-necklace model with continuous medium approximation. Proper account is taken not only of the inter-molecular interaction but also of the intramolecular interaction of segments or the so-called "excluded volume effect". Evaluation is carried out to the triple contact approximation. The results show that the intramolecular interaction has a marked influence on the molecular weight

dependence of the coefficient. Theories of the intrinsic viscosity and frictional coefficient are developed on the same model, following the Kirkwood and Riseman scheme. The results show that, if α is the linear expansion factor of the polymer coil, the intrinsic viscosity is asymptotically proportional to α^2 for the free-draining case and $\alpha^{2.4}$ for the impermeable case. This implies that even in the limit for impermeable molecule, the hydrodynamic radius of the ploymer coil is not proportional to its statistical radius. Finally a comparison of the theory with experimental data is made, taking solutions of polystyrene in cyclohexane as an example. The results prove that the theory is very fitted for structural interpretation of experimental data. A.

532.77 : 536.7

8621. STATISTICAL THERMODYNAMICS OF POLYMER SOLUTIONS. I. THEORY OF THE SECOND VIRIAL COEFFICIENT FOR A HOMOGENEOUS SOLUTE. E.F.Casassa and H.Markovitz.
J. chem. Phys., Vol. 29, No. 3, 493-503 (Sept., 1958).

A approximate theory of the second virial coefficient A_2 for a system of identical random flight polymer chains of n steps, of average length b, is developed on the basis of a treatment by Zimm in power series form which, though formally exact, is not rapidly enough convergent to be practically useful. By introducing, as an approximation, a spherically symmetrical distribution of the chain segments of two interacting molecules averaged relative to the locus of an initial intersegmental contact, it becomes possible to sum the series, the terms of which relate to molecular configurations with progressively greater numbers of simultaneous contacts. The result, a double integral, is evaluated numerically; but the simple relation

$$A = \text{const}[1 - \exp(1.42\psi)]/1.42\psi,$$

in which $\psi = 4\beta n^{1/2}(3/2\pi b^2)^{3/2}$ and β is the mutually excluded volume for a pair of segments, differs from the integral by less than one percent for all positive values of the parameter ψ. The analytical form of this equation is justified in terms of the theory. Virial coefficients calculated from the theory with parameters derived from intrinsic viscosity measurements agree fairly well with the observed dependence on solute molecular weight for two systems in good solvents, but the magnitudes obtained are too small. If, however, the parameters of the theory are considered arbitrary, correspondence with experiment, to within errors of measurement, can be achieved. A.

532.77 : 541.135

8622. SCREENED INTERACTIONS OF NEIGHBOR IONS AND SYMMETRY PROPERTIES OF TITRATION CURVES IN POLYELECTROLYTES. J.Warga and S.Lifson.
J. chem. Phys., Vol. 29, No. 3, 643-4 (Sept., 1958).

A model of neighbour ions interactions in polyelectrolytes is treated, in which it is assumed that a fixed ion inserted between two other fixed ions acts as a screen, so that two fixed ions may interact only if there are no other fixed ions inserted between them. It is shown that the effect of screening is to increase the buffering capacity at higher degrees of ionization. The results of the model are compared with those of other models of neighbour interactions. A.

MECHANICS OF GASES

533.15

8623. MEASUREMENTS OF He^3–He^4 AND H_2–D_2 GAS DIFFUSION COEFFICIENTS. P.J.Bendt.
Phys. Rev., Vol. 110, No. 1, 85-9 (April 1, 1958).

The gas diffusion coefficient for He^3–He^4 was measured between 1.74 and 296°K, and for H_2–D_2 between 13.9 and 296°K. The diffusion bridge used to make the measurements is described. The experimental results are compared with viscosity measurements, and with classical and quantum-mechanical calculations based on the Lennard-Jones 12-6 and on the modified Buckingham exp-6 intermolecular potential fields. A.

533.15 : 551.574

DETERMINATION OF THE DIFFUSION COEFFICIENT OF CONDENSATION NUCLEI. See Abstr. 8555

533.15 : 541.183

DIFFUSION AND HETEROGENEOUS REACTION. THE DYNAMICS OF RADICAL REACTIONS. See Abstr. 9173

533.59 : 537.562

8624. TRAPPING OF HELIUM IONS AND THE RE-EMISSION OF TRAPPED ATOMS FROM MOLYBDENUM.
L.J.Varnerin and J.H.Carmichael.
J. appl. Phys., Vol. 28, No. 8, 913-19 (Aug., 1957).

The electrical clean-up of helium on molybdenum surfaces was investigated. In this case, the phenomenon can be described by a trapping of ions upon impact with the surface. Measurements of the trapping efficiency η (atoms removed/ions collected) were made over a range of ion energies from 150 to 2600 eV. The re-emission of trapped helium atoms was investigated in detail. The contribution of re-emission to the pumping process is described by a phenomenological theory. The results indicate that the trapping efficiency is lowered by a short time re-emission of trapped atoms. Through the long-time re-emission of atoms, the theory accounts quantitatively for the observed saturation of the clean-up process. A.

533.59

8625. CONSTRUCTION OF SMALL FIXED LEAKS OF PREDICTABLE THROUGHPUT. S.A.Gordon.
Rev. sci. Instrum., Vol. 29, No. 6, 501-4 (June, 1958).

A method is described by which glass capillary leaks with extremely small flow rates can be easily and rapidly produced. The predictability of these leak rates is determined by the resolution of the optical system used in measurement of bore diameter. Data are presented which will allow construction of such leaks. A manifold of leaks is described which will introduce gas into a high vacuum system at several different fixed leak rates. It contains no moving parts or high vapour-pressure material on the high vacuum side, yet the leak rates can be manipulated over a wide range. The characteristic features of these leaks are shown to be reasonable in light of well established theory. A.

533.59 : 539.27

A VACUUM EVAPORATION DEVICE FOR ELECTRON MICROSCOPY. See Abstr. 9150

533.6.011.4

8626. ON THE DRAG OF A SPHERE AT EXTREMELY HIGH SPEEDS. V.C.Liu.
J. appl. Phys., Vol. 29, No. 2, 194-5 (Feb., 1958).

The formula for the pressure-drag coefficient of a sphere which moves at extremely high speeds is derived. In the derivation it is assumed that the nose of the shock contour follows exactly the frontal half of the spherical surface and the local pressure on the frontal spherical surface corresponds to the pressure behind the shock wave after the statistical equilibrium between the various degrees of freedom of the molecule has been reached. The chemical dissociation of the molecules behind the shock wave is taken into account in the analysis. The theoretical results of the drag coefficient of the spheres agree with the corresponding available measured value within the experimental error for the range of Mach number between 5 and 10. A.

533.6.011.4

8627. HEAT TRANSFER TO A SPHERE AT THE TRANSITION FROM FREE MOLECULE FLOW. P.Hammerling and B.Kivel.
Phys. of Fluids, Vol. 1, No. 4, 357-8 (July-Aug., 1958).

Using similar assumptions to those of Baker and Charwat (Abstr. 2871/1958) but slightly different methods, the total energy given to a sphere per unit time is stated to have been deduced as

$$E \cong \tfrac{1}{2}\pi a^2 \rho_0 m V_0^3 [1 - (V_e/V_0)^2][1 - 0.2\, a\rho_0 S_{eo} V_0/V_e],$$

where $\rho_0 m$ is the ambient mass density, and the derivation is discussed in general terms. The difference between the coefficient 0.2 and 0.46 in the expression of Baker and Charwat and the importance of surface temperature are also discussed.

S.Weintroub

MOLECULAR THEORY OF GASES

533.7

8628. GASEOUS SPECIES IN THE VAPORIZATION OF SODIUM HYDROXIDE. R.C.Schoonmaker and R.F.Porter.
J. chem. Phys., Vol. 28, No. 3, 454-7 (March, 1958).

Mass spectrometric studies of the gaseous species in sodium hydroxide vapour show that in the temperature range 300°C to 450°C, NaOH (l) vaporizes mainly as gaseous dimers. A thermodynamic treatment of ion current data yields for the reactions:

$2NaOH(l) = Na_2(OH)_2(g)\Delta H^0_{660°K} = 28 \pm 3$ kcal/mole of dimer
$NaOH(s) = NaOH(g)\Delta H^0_{298°K} = 46.4 \pm 3$ kcal/mole of NaOH
$2NaOH(g) = Na_2(OH)_2(g)\Delta H^0_{660°K} = -54 \pm 5$ kcal/mole of dimer.

Comparison with existing data on the gaseous alkali halides shows the trend in dimerization energies:

$$NaOH(g) > NaCl(g) > NaF(g).$$

A.

533.7 : 532.7 : 530.162

NODAL EXPANSIONS OF POTENTIALS OF AVERAGE FORCE AND DISTRIBUTION FUNCTIONS. GENERAL EXPANSION OF N-TH ORDER. See Abstr. 8600

533.7

8629. MOLECULAR ASSOCIATION OF METHANOL VAPOR.
R.G.Inskeep, J.M.Kelliher, P.E.McMahon and B.G.Somers.
J. chem. Phys., Vol. 28, No. 6, 1033-6 (June, 1958).

The absorption of infrared radiation by methanol vapour in the region 3200 to 3800 cm^{-1} was studied at 305° and 335° K as a function of vapour density. The results best correlate with the model that methanol vapour is composed of monomer, dimer and tetramer, with little or no trimer present. The heat of dissociation of the dimer is found to be approximately 3 kcal/mole, and that of the tetrameter approximately 17 kcal/mole. The greater stability of the tetramer compared to the dimer is consistent with a cyclic structure for the tetramer. A.

533.7

8630. POLYMERIC GASEOUS MOLECULES IN THE VAPORIZATION OF ALKALI HALIDES.
J.Berkowitz and W.A.Chupka.
J. chem. Phys., Vol. 29, No. 3, 653-7 (Sept., 1958).

The molecular species of alkali halide vapours in equilibrium with their respective condensed phases are deduced by a mass spectrometric analysis of the ions produced by electron impact. Dimers, trimers, and in some instances tetramers M_nX_n were observed, with the lithium halides exhibiting more dimeric than monomeric species. The results are in substantial agreement with earlier molecular beam velocity selector experiments, and discordant with some recent infrared spectral studies. Some oddities in the ionization efficiency curves are also discussed. A.

VIBRATIONS. ACOUSTICS

534.1

8631. FINE STRUCTURE OF RESPONSE CURVES OF FREQUENCY ENTRAINED OSCILLATIONS.
C.A.Ludeke and J.D.Blades.
J. appl. Phys., Vol. 28, No. 11, 1326-8 (Nov. 1957).

By simulating with an electro-mechanical analogue a forced van der Pol-like system, it was possible to observe some of the jump and hysteresis phenomena suggested by Cartwright (1948). The dependence of entrainment bandwidth on forcing amplitude, as suggested by Andronow and Witt, was also observed. A.

534.13

8632. VIBRATION OF AXIALLY LOADED BEAMS CARRYING DISTRIBUTED MASSES. H.L.Cox.
J. Acoust. Soc. Amer., Vol. 30, No. 6, 568-71 (June, 1958).

The lowest two natural frequencies of flexural vibration are obtained, by the use of energy methods, for uniform axially loaded beams which rest on elastic foundations and which carry masses that may be distributed symmetrically along portions of the spans of the beams. The ends of the beams may be either pinned or clamped. Simple formulae for the lowest two frequencies are given so that one may compute rapidly a desired frequency and determine the effects of the various parameters which influence that frequency. A.

534.131 : 534.442

8633. AVERAGING TIME AND DATA-REDUCTION TIME FOR RANDOM VIBRATION SPECTRA. I. C.T.Morrow.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 456-61 (May, 1958).

Most narrow-band-width wave analysers currently available on the market were designed for producing spectra of periodic signals. When they are applied to producing spectra for low-frequency random signals such as occur in vibration, a longer averaging time must be provided on the output side of the detector circuit to average out fluctuations and yield data of satisfactory statistical significance. The application of standard statistical techniques in relation to the band-width of the selective circuit provides design data for averaging circuits to be added as modifications to existing analysers. Proper averaging time carries with it a requirement of a slower sweep rate and hence greatly increases the time required for producing a spectrum. Techniques and apparatus for producing a spectrum in a decreased time interval are discussed. A.

534.131 : 534.442

8634. AVERAGING TIME AND DATA-REDUCTION TIME FOR RANDOM VIBRATION SPECTRA. II. C.T.Morrow.
J. Acoust. Soc. Amer., Vol. 30, No. 6, 572-8 (June, 1958).

In Pt I, formulae were given for uncertainty when a power-spectral-density plot is estimated from a short sample of random vibration. The relation between this problem and the time required to obtain the spectrum was investigated for the sweeping of a simple analyser through the frequency band. Other methods of obtaining the spectrum are now discussed. A.

534.131

8635. SOME CHARACTERISTICS OF THE FLEXURAL VIBRATIONS OF ORTHOGONALLY STIFFENED CYLINDRICAL SHELLS.
W.H.Hoppmann, II.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 803 (Aug., 1958).

The author replies to some criticisms of his paper (see Abstr. 6729/1958) by Galletly. The main difference between the author's treatment and that of Huber is that Huber considered only the small flexure of plates under static bending and twisting, whilst the author considered moderately large dynamic deflections of plates and flexures of stiffened shells, taking into account bending, twisting, stretching and shearing. H.J.H.Starks

534.131

8636. FLEXURAL VIBRATIONS OF STIFFENED CYLINDERS.
G.D.Galletly.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 804 (Aug., 1958).

The author makes further comments on Hoppmann's reply (see preceding abstract) and summarizes the correspondence; he points out that the methods of Bleich, Galletly and Hoppmann for calculating the frequencies of vibration of ring-stiffened cylinders give, for all practical purposes, similar results. Hoppmann's method, however, requires additional experiments. H.J.H.Starks

534.131

8637. THE HORIZONTAL PERIODIC FORCES ACTING ON A TOWER BY RINGING OF BELLS. W.Kallenbach.
Z. angew. Phys., Vol. 9, No. 5, 260 (May, 1957). In German.

In the author's previous paper (Abstr. 1975/1957), the tower was considered as a mathematical pendulum. A simple way is now described for expressing the earlier results in terms of a physical pendulum. H.J.H.Starks

534.2

8638. CHARACTERISTIC IMPEDANCES FOR FLEXURE WAVES IN THIN PLATES. D.A.Thomas.
J. Acoust. Soc. Amer., Vol. 30, No. 3, 220-1 (March, 1958).

Boundary conditions are applied to the general solution of the thin-plate wave equation to obtain the solution for outgoing flexure waves in an infinite plate. This solution is used to obtain expressions for a bending moment characteristic impedance and a shear force characteristic impedance. Graphs of these impedances are presented. A.

534.2

8639. ELASTIC STRAIN PRODUCED BY SUDDEN APPLICATION OF PRESSURE TO ONE END OF A CYLINDRICAL BAR.
I. THEORY. R.Folk, G.Fox, C.A.Shook and C.W.Curtis.
J. Acoust. Soc. Amer., Vol. 30, No. 6, 552-8 (June, 1958).

A double transform method is used to solve the problem of determining the elastic strain in a semi-infinite cylindrical bar with a stress-free lateral surface, subject to the end conditions that the stress applied normally to the end is uniform and has a step-function time dependence and that the radial displacement at the end is always zero. The exact solution appears as a sum of Fourier integrals whose integrands have the form of Pochhammer–Chree waves. These integrals cannot be evaluated in general by simple means, but asymptotic solutions were obtained which are valid for large distances of travel. The theoretical predictions are compared with the results of experiment in a companion report. A.

534.2

8640. ELASTIC STRAIN PRODUCED BY SUDDEN APPLICATION OF PRESSURE TO ONE END OF A CYLINDRICAL BAR.
II. EXPERIMENTAL OBSERVATIONS. G.Fox and C.W.Curtis.
J. Acoust. Soc. Amer., Vol. 30, No. 6, 559-63 (June, 1958).

Measurements are presented which show that the elastic strain produced in a cylindrical bar by step-function end-loading corresponds closely to predictions of the theory presented in Pt I. In particular, even at large distances from the end of the bar, there is an observable strain moving faster than the bar velocity determined by Young's modulus. The theoretical shape for the head of the pulse

conforms to experiment, and the head is followed by oscillations having the correct periods and amplitudes. Second-mode oscillations appear at the times predicted and with the expected periods and amplitudes. A.

534.213 : 532.7

8641. ON THE ATTENUATION OF FINITE AMPLITUDE WAVES IN A LIQUID. I.Rudnick.
J. Acoust. Soc. Amer., Vol. 30, No. 6, 564-7 (June, 1958).

An expression is obtained for the rate of attenuation of large amplitude waves of stable form propagated in a liquid whose attenuation varies as the square of the frequency. Calculations are presented for several liquids and comparison is made with recent published data. A.

534.22

8642. MINIMUM AXIAL PHASE VELOCITY IN SHELLS. P.W.Smith, Jr.
J. Acoust. Soc. Amer., Vol. 30, No. 2, 140-1 (Feb., 1958).

A new approximate expression is proposed for the frequency of the point of minimum velocity of a free wave in a cylindrical shell which is more accurate for higher values of the order number m (displacements ~ $\cos m\theta$). This and earlier approximations are compared with results of precise calculations. The transition between approximations is discussed. A.

534.22 : 532.7

8643. DISPERSION AND ABSORPTION OF SOUND IN ETHYL FORMATE AND STUDY OF THE ROTATIONAL ISOMERS. D.Tabuchi.
J. chem. Phys., Vol. 28, No. 6, 1014-21 (June, 1958).

It was shown by Karpovich (Abstr. 133/1955) that there is relaxational absorption of sound in liquid ethyl formate and that it results from the rotational isomerism about the C—O bond. Dispersion of sound velocity is expected from the absorption data, and its existence is confirmed by the present experiments. The sound velocities are measured over the frequency range from 300 kc/s to 9 Mc/s and at 5 deg C intervals from 10° to 40° C by an ultrasonic interferometer. From these experimental results, the energy differences, the equilibrium constant, the rate of isomerization, and the height of the potential barrier hindering the internal rotation are calculated. The value of the energy difference is 2.50 kcal/mole and the height of the potential barrier, referred to the higher energy state, is 3.38 kcal/mole. The calculated values of the heat capacity owing to the chemical reaction, the sound velocity at infinite frequency, and the maximum values of the absorption coefficient of sound per wavelength are in good agreement with the experimental data. A.

534.22 : 536.48

PROPAGATION OF ORDINARY SOUND IN LIQUID HELIUM NEAR λ POINT. See Abstr. 7769

534.222.2

8644. PRODUCTION OF HIGH-VELOCITY SHOCKS. V.Josephson.
J. appl. Phys., Vol. 29, No. 1, 30-2 (Jan., 1958).

High-velocity axial shocks were produced in linear gas discharge systems by so shaping the discharge tube (and discharge) that a maximum amount of energy is coupled into the ionized gas before the shock is formed. Two methods of coupling energy into the gas are discussed along with their relative merits and shock velocities achieved by each method. A.

534.222.2

8645. INITIAL WAVE PHENOMENA IN A WEAK SPHERICAL BLAST. R.G.Campbell.
J. appl. Phys., Vol. 29, No. 1, 55-60 (Jan., 1958).

The initial waves created by the sudden release of a spherical volume of compressed air in a limitless environment of air at constant state are predicted analytically using an iterative method of solution by characteristics for the case of a specific weak blast. Pressure—time records were obtained within the compressed air and in the immediate environment of the spherical blast during its early stages using a pyramidal shock tube. The experimental results corroborate the existence and position in time and space of the inner and reflected shock waves predicted analytically. The present results for a weak spherical blast are in substantial agreement with the analytical and experimental results obtained previously by other investigators for a considerably more powerful blast. The shock tube, in pyramidal or conical form, appears to offer considerable promise for further research on spherical blast phenomena. A.

534.222.2

8646. ABNORMALLY HIGH DETONATION PRESSURES IN A SHOCK TUBE. I.Ginsburgh.
J. appl. Phys., Vol. 29, No. 9, 1381-2 (Sept., 1958).

Evidence is given of extremely high transitory pressures during spark ignited detonations; pressures up to 30 000 lb/in^2 are obtained from a butane—oxygen mixture, initially at 40 lb/in^2. A qualitative explanation is suggested; this assumes that, at initiation, the detonation wave is travelling through shock-heated gas and travels at excess speed until it catches the front. A.G.Gaydon

534.222.2 : 778.33

8647. APPARATUS FOR PRECISION FLASH RADIOGRAPHY OF SHOCK AND DETONATION WAVES IN GASES. H.T.Knight and D.Venable.
Rev. sci. Instrum., Vol. 29, No. 2, 92-8 (Feb., 1958).

An apparatus is described which is based on the technique introduced by Kistiakowsky (Abstr. 2767/1957) utilizing the absorption of soft X-rays to measure densities behind gaseous shock and detonation waves. Experimental conditions leading to the smallest absorption statistical uncertainty consistent with maximum sensitivity are defined. These may be approximated at reasonable pressures and tube diameters by adding a strongly absorbing rare gas diluent to the experimental gas mixture. Under such conditions measured densities are accurate to ± 1%, as demonstrated by comparison of experimental and calculated densities for shock waves in krypton. At some sacrifice in accuracy, space resolution of 1 mm and time resolution of 1 μsec may be achieved. A continuously pumped, demountable, pulsed X-ray tube with an L-cathode and tungsten target is used at an accelerating voltage of 20-30 kV to obtain currents up to 0.2 A for durations of the order of 1 msec. Copper and chromium targets were also investigated. For calibration purposes the tube is operated at a steady current of ≅ 0.2 mA, and detector signals are measured potentiometrically to obtain transmission as a function of gas density. A.

534.23 : 532.13

8648. ORIGIN OF ULTRASONIC VOLUME VISCOSITY IN ASSOCIATED LIQUIDS. T.A.Litovitz.
J. Acoust. Soc. Amer., Vol. 30, No. 3, 210-14 (March, 1958).

Thermodynamic data on specific heat, and thermal expansion coefficient of glycerol in the liquid and glass state are used to investigate the origin of the ultrasonic volume viscosity losses and associated dispersion in liquid glycerol. It is shown that the volume relaxation effects cannot be accounted for on the basis of a thermal relaxation involving either the vibrational specific heat or the structural specific heat. It is concluded that the volume viscosity in glycerol (and most probably in all the associated liquids) has an origin similar to that found for water, namely a relaxing isothermal compressibility. A.

534.23 : 532.7

8649. EFFECT OF HIGH PRESSURE ON SOUND ABSORPTION AND CHEMICAL EQUILIBRIUM. F.H.Fisher.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 442-8 (May, 1958).

A technique was evolved to measure sound absorption in liquids as a function of pressure at frequencies of 100-600 kc/s. The following properties of a 0.5 molar solution of $MgSO_4$ were measured up to 20 000 lb/in.^{2} at 26°C: absorption, relaxation frequency and velocity. The absorption at 20 000 lb/in.^{2} is less than one quarter that at atmospheric pressure and the relaxation frequency remains constant at 1.2×10^6 rad/sec over this pressure interval within the estimated experimental error of ±10%. The velocity increases linearly with pressure at the rate 0.1588 m/atm. From these data the chemical and adiabatic compressibilities are computed. In an effort to secure quantitative agreement with experimental results some new aspects of the dissociation theory are discussed. A.

534.23

8650. ABSORPTION AND DISPERSION OF SOUND IN CHEMICALLY REACTING FLUIDS. R.M.Mazo.
J. chem. Phys., Vol. 28, No. 6, 1223-9 (June, 1958).

The hydrodynamic equations for a reacting fluid mixture, in the form given by Kirkwood and Crawford (J. phys. Chem., Vol. 86, 1048, 1952), are used to find the dispersion and absorption of plane infinitesimal sound waves. Only the case of no internal relaxations is treated. The equation for the absorption and dispersion is simplified for commonly occurring special cases, and it is shown that the viscothermal and chemical absorptions and dispersions are additive to first order. The effects of diffusion currents are estimated and found to be negligible. A.

534.23 : 537.228

8651. INFLUENCE OF ELECTROSTATIC FIELD ON THE ABSORPTION OF SOUND IN ROCHELLE SALT.
I.A.Yakovlev, T.S.Velichkina and K.N.Baranskiĭ.
Zh. éksper. teor. Fiz., Vol. 33, No. 4(10), 1075-7. In Russian.
English translation in: Soviet Physics — JETP (New York), Vol.6, No. 4, 830-1 (April, 1958).

The absorption of 1.5 msec pulses of 5 Mc/s waves was measured along the ferroelectric x-axis of the crystal which was polarized by an electric field of 600 V/cm directed along the same x-axis. At temperatures T above the upper Curie point θ_c sound absorption is independent of the electric field, at temperatures well below θ_c there is a weak dependence, but for $T-\theta_c \cong 0.2$ deg C there is a marked dependence. C.A.Hogarth

534.23 : 538.221 : 536.21

ABSORPTION OF SOUND IN FERROMAGNETIC DIELECTRICS. See Abstr. 7856

534.231

8652. SHALLOW WATER TEST OF THE THEORY OF LAYERED WAVE GUIDES. I.Tolstoy.
J. Acoust. Soc. Amer., Vol. 30, No. 4, 348-61 (April, 1958).

Quantitative agreement between theory and experiment was secured for the acoustical radiation field of a simple harmonic point source of known power output, at low frequencies in shallow water. The experiment covered the range of frequencies 88-148 c/s in water 22.6 m deep in a location on the Atlantic seaboard. All instruments were calibrated. Absolute sound levels and details of mode interaction agree quite well with those predicted by the guided wave solution for a three layered liquid half space, proper account being taken of locally measured mode attenuation coefficients. These are small and are essentially introduced into the undamped theory in a posteriori, phenomenological fashion. Emphasis is given to the importance of correctly determining the acoustical parameters of the various layers, and it is shown that minor changes in these may produce effects sufficient to destroy agreement between theory and experiment. The use of various criteria, and in particular of dispersion and mode-interaction wavelengths is illustrated in this connection. A.

534.232

8653. NEW TECHNIQUE FOR MEASURING TRANSDUCER BLOCKED IMPEDANCE. G.A.Sabin.
J. Acoust. Soc. Amer., Vol. 30, No. 2, 146-50 (Feb., 1958).

A pulsing technique for measuring the blocked impedance of an electroacoustic underwater sound transducer is described. The method permits measuring the blocked impedance under free-field acoustic loading conditions without resorting to clamping the transducer or to the usual interpolation method. Both theory and measurements are discussed. A means of readily identifying the natural resonance frequency from either an impedance or an admittance plot is also presented. A.

534.232 : 533.6.011

8654. ACOUSTIC RADIATION FROM ISOTROPIC TURBULENCE. W.C.Meecham and G.W.Ford.
J. Acoust. Soc. Amer., Vol. 30, No. 4, 318-22 (April, 1958).

For low Mach number turbulence, Lighthill (Abstr. 3372/1952, 8295/1953, 3188/1954) has given a result which expresses the acoustic radiation of turbulent fluid in terms of a fourth-rank velocity correlation. Through the use of the Navier–Stokes equation this relation can be put in terms of the space-time pressure correlation. For very large Reynolds number turbulence (in the inertial subrange where Kolmogoroff's similarity principles are valid) one can write this pressure correlation in terms of a function of a single variable. Since the space–time correlation of the pressure is needed one must take into account convective effects. This is done here by introducing a new Lagrangian type of correlation which is defined in such a way that a similarity argument can be applied without difficulty from the convective effects. Such convective effects then enter only through negligible Doppler shifts. Using this similarity result and Lighthill's formulation, one obtains the acoustic self-noise power spectrum for the turbulence. The spectrum is proportional to $\omega^{-7/3}M^{23/3}$ for high frequencies ($\omega \gg c_0 M/L$), where ω is the acoustic angular frequency, M is the turbulence Mach number, c_0 is the velocity of sound in the fluid, and L is the size of the large-scale turbulent eddies. The spectrum at the high-frequency end is universal, that it is independent of the details of the driving mechanism. Furthermore the spectrum is proportional to $\omega^4 M^3$ at the low-frequency end and depends on the large-scale eddies there. The similarity hypothesis made here for the special Lagrangian type of space-time correlation is of interest in itself in turbulence theory. It is difficult to check this hypothesis directly; however, a measurement of the acoustic power spectrum offers an interesting indirect check on the hypothesis. A.

534.232 : 534.832

8655. EFFICIENCY OF A LINEAR ARRAY OF POINT SOURCES WITH LINEAR PHASE VARIATION.
G.J.Thiessen and T.F.W.Embleton.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 449-52 (May, 1958).

The radiation efficiency of a linear array of point sources with linear phase variation is solved using different approximations for different ranges of the phase parameter. The results are compared with experimental results on small models and also on full-scale suction rolls in paper mills with different drilling patterns. The experiments agree quite closely with theory and indicate that a noise reduction of 15 to 30 dB can be obtained by the choice of a substitute drilling pattern that can easily be drilled by multiple spindle machines. Design charts for choosing and evaluating drilling patterns are given. A.

534.232

8656. NONLINEAR ACOUSTIC PROPERTIES OF ORIFICES OF VARIED SHAPES AND EDGE CONDITIONS. G.B.Thurston.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 452-5 (May, 1958).

The results of a study of the effect of shape and orifice edge conditions on the nonlinear acoustic properties of orifices are presented. The samples studied consisted of orifices of circular, rectangular, and square shape in thin orifice plates. Varied edge conditions considered are square, round, and symmetric and nonsymmetric bevelled edges for circular orifices in thick plates. These samples were studied for sinusoidal volume velocity in the orifice. It is found that for all the symmetric samples the pressure contains odd harmonics while for the nonsymmetric sample a steady component and second harmonic component are superimposed on the odd harmonics. An equation for the pressure-flow relation is given which is applicable to both symmetric and nonsymmetric orifices. A.

534.232 : 534.874 : 551.46

8657. ARRAYS FOR THE INVESTIGATION OF AMBIENT NOISE IN THE OCEAN. V.C.Anderson.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 470-7 (May, 1958).

A discussion of the important parameters to be considered in the use of directional arrays for the study of noise fields in the ocean leads to specialized array designs. Some properties of circular and spherical arrays composed of omnidirectional elements are presented. Consideration of these properties leads to an optimum selection of geometry and element spacing for each of these two cases: a distributed noise source, and a set of point noise sources. The calculation of directivity index for a spherical array is carried out by the use of the space-correlation functions of an isotropic noise field. The measured, broad-band directivity pattern of a model circular plane array as a function of frequency is also shown. A.

534.232

8658. DISTRIBUTED TRANSDUCER.
M.Greenspan and R.M.Wilmotte.
J. Acoust. Soc. Amer., Vol. 30, No. 6, 528-32 (June, 1958).

The distributed transducer is an array of transducers separated by inactive material having their common characteristic impedance, Z_0, and terminated in Z_0 at one (the absorber) end. The other end radiates into a load. The input voltages at the successive inputs are delayed so that the speed of the electrical wave, travelling in the direction absorber to load, equals the speed of sound in the transducer material. The elements may or may not be identical and they may or may not be operated near resonance; the acoustic waves arrive at the load in phase in any case. A great variety of frequency-response characteristics is readily synthesised; particular attention is paid to a flat response over a very broad range. At the same time, the response at the absorber is subject to some control so that the power there dissipated can be minimized. A.

534.232 : 538.652 : 538.27 : 621.318.12

NICKEL FERRITE AS TRANSDUCER MATERIAL. See Abstr. 8143

534.24 : 551.481.18

REFLECTION OF ACOUSTIC WAVES AT THE BOTTOM OF A LAKE. See Abstr. 9183

534.7

PHYSIOLOGICAL ACOUSTICS. HEARING. See also under "Medical science. Human physiology". Decimal classification 612.85

534.78

8659. ON THE POWER GAINED BY CLIPPING SPEECH IN THE AUDIO BAND. W.Wathen-Dunn and D.W.Lipke.
J. Acoust. Soc. Amer., Vol. 30, No. 1, 36-40 (Jan., 1958).

For more than a decade it has been known, in a qualitative way, that the long-time average power of a speech signal in an amplitude-limited communications system can be increased materially by clipping the peaks of the speech wave and amplifying the remainder until the new peaks have the maximum allowable amplitude. This power increase can be computed from the statistical distribution for the instantaneous amplitudes of speech. Some of the available distributions were collected and compared, and, upon their showing good agreement, one of them was used for the computation. Simple formulae show that the power increase can be neither greater than the amount of clipping nor greater than the peak factor of speech. For 24 dB of peak clipping, the power gain is about 12 dB. The exact value depends upon the choice of peak factor for unclipped speech. In practice, the actual gain in signal-to-noise ratio on peak-limited communications systems (e.g. AM and DSB radio) will be less than that computed here. A.

534.782 : 612.85

8660. EFFECT OF THIRD-FORMANT TRANSITIONS ON THE PERCEPTION OF THE VOICED STOP CONSONANTS.
K.S.Harris, H.S.Hoffman, A.M.Liberman, P.C.Delattre and F.S.Cooper.
J. Acoust. Soc. Amer., Vol. 30, No. 2, 122-6 (Feb., 1958).

Experiments using synthetic speech show that third-formant transitions are cues for the perception of /b,d,g/. Detailed results are presented for a variety of third-formant transitions paired with each of a number of second-formant transitions in initial position before the vowels, /i/ and /æ/. The results obtained with various third-formant transitions depend in part on the steady-state level of the third-formant, implying the existence of third-formant loci analogous to those previously found for the first and second formants. The data of the present experiment are not sufficient to permit a specification of these loci. The effects of third-formant cues are independent of the two-formant patterns to which they are added. When a third-formant cue enhances the perception of a particular phoneme, it typically does not do so equally at the expense of the other response alternatives. A.

534.79

8661. PROPOSAL FOR AN EXPLANATION OF LIMENS OF LOUDNESS. J.R.Pierce.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 418-20 (May, 1958).

It is proposed that the limen of loudness ΔS for pure tones is equal or proportional to the root-mean-square deviation in the number of pulses produced by the sound in the time T of observation. By making a plausible assumption concerning the deviation and by assuming that loudness S is proportional to the pulse rate one obtains $\Delta S = A^{-1/2}T^{-1/2}S^{-1/2}$. Here A is a constant which must be a function of frequency if the equation is to fit experimental data. The fit is encouraging but not completely convincing. If valid, the hypothesis might be used to explain other acoustic phenomena. A.

534.833 : 533.6.011

8662. EXPERIMENTS ON THE INFLUENCE OF FLOW ON SOUND ATTENUATION IN ABSORBING DUCTS.
E.Meyer, F.Mechel and G.Kurtze.
J. Acoust. Soc. Amer., Vol. 30, No. 3, 165-74 (March, 1958).

The influence of a turbulent air stream on the sound attenuation in ducts lined with sound absorbing materials or structures of different kinds, was experimentally investigated. For linings consisting either of porous materials or sufficiently damped Helmholtz resonators, a decrease of absorption with increasing flow velocity was observed, together with an increase of the frequency of maximum absorption in the case of the resonators. Somewhat surprising results were obtained for undamped or weakly damped Helmholtz resonators, where an attenuation minimum is observed above the resonant frequency, the frequency of which increases linearly with increasing flow velocity, and which — for undamped resonators — even reaches negative attenuation values. Aside from the negative attenuation, a self-excitation of the duct is observed under certain conditions, the frequency of which is not identical with the attenuation minimum. A.

534.833 : 534.23

8663. ATTENUATION OF SOUND IN LINED AIR DUCTS.
A.J.King.
J. Acoust. Soc. Amer., Vol. 30, No. 6, 505-7 (June, 1958).

Theoretical predictions of the performance of silencers are apt to be difficult and unreliable, so experimental results are often very valuable. A previous paper (see Abstr. 1480/1948) contained curves giving the attenuation of sound with frequency in lined ducts of various widths and thicknesses of lining of rock wool. Subsequent experience has shown the need for an extension of these curves to cover thicker linings and splitters, and advantage has been taken of an opportunity to obtain further data on 16 in. splitters and air channels. New curves including these data are given for a 50% space factor, together with an extrapolation to 32 in. splitters. Thickness greater than 16 in. are unlikely to be used unless frequencies lower than 100 c/s are important. For covering very wide frequency bands two stage filters are recommended. A.

534.838.1

8664. SONIC VIBRATION AS EXEMPLIFIED BY THE RB-66B AIRPLANE. D.C.Kennard, Jr.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 462-9 (May, 1958).

534.839 : 534.79

8665. LOUDNESS OF PERIODICALLY INTERRUPTED WHITE NOISE. I.Pollack.
J. Acoust. Soc. Amer., Vol. 30, No. 3, 181-5 (March, 1958).

The burst level of a periodically, abruptly interrupted, white noise, necessary to match a continuous noninterrupted white noise in loudness, was examined over a wide range of interruption conditions. A procedure for calculating the required burst level, with knowledge only of the time-intensity characteristics of the interrupted noise, is outlined. A.

534.84

8666. SMALL ROOM EXCITED BY AN ORGAN PIPE. COUPLING AND BEATS. Z.Carrière.
Cahiers de Phys., Vol. 12, 1-7 (Jan., 1958). In French.

Experiments on the modes of vibration of the coupled system.
H.D.Parbrook

534.846

8667. ACOUSTICAL DESIGN OF THE ALBERTA JUBILEE AUDITORIA. T.D.Northwood and E.J.Stevens.
J. Acoust. Soc. Amer., Vol. 30, No. 6, 507-16 (June, 1958).

Two large auditoria have recently been built by the Province of Alberta, Canada, in the cities of Edmonton and Calgary. The main auditoria, which seat 2700 persons, are designed for both concert and large-scale stage presentations. This paper reports on the design and on the extensive acoustical testing in the laboratory and in the halls themselves. Impedance tube and reverberation chamber data were obtained for materials and components of the auditoria. Reverberation time, pulse tests, and other objective measurements were made in the halls as they approached completion. The project culminated in a test concert attended by about 1800 people. A.

534.87 : 534.78

8668. SPEECH ANNUNCIATOR WARNING INDICATOR SYSTEM: PRELIMINARY EVALUATION. I.Pollack and J.Tecce.
J. Acoust. Soc. Amer., Vol. 30, No. 1, 58-61 (Jan., 1958).

The principle of a speech annunciator as a warning signal indicator (e.g. in military aircraft) was evaluated in three experiments against a master warning signal. With respect to two important criteria of performance (warning signal identification time and performance upon a concurrent visual-motor tracking test), the speech annunciator was clearly superior to the master warning indicator. With respect to two other criteria of performance (initial warning detection and performance upon a concurrent message-reproduction task), the speech annunciator was equivalent to the master warning indicator. The results suggest that a speech annunciator, perhaps coupled with a master indicator, may be a useful warning indicator system. A.

OPTICS. RADIATION. SPECTRA

535.23 : 535.39 : 537.311.33

8669. THE INFRARED EMISSIVITIES OF INDIUM ANTIMONIDE AND GERMANIUM. T.S.Moss and T.D.H.Hawkins.
Proc. Phys. Soc., Vol. 72, Pt 2, 270-3 (Aug., 1958).

The materials were used in thin single crystal slices heated electrically in the open, their temperatures being determined by their resistances. The InSb had an extrinsic carrier concentration about 10% of the intrinsic; between 35° and 142° C the emission edge near 8μ shifted by -2.9×10^{-4} eV/deg C, and from the minimum emissivity observed the absorption coefficient was calculated as 55 cm^{-1}. The absolute emissivity at short wavelengths agreed with calculations from the optical constants. The Ge was near intrinsic, and between 135° and 235° C gave a shift of the absorption edge near

2μ of -5×10^{-4} eV/deg C. The absorption coefficient was calculated as 4 cm^{-1}. S.T.Henderson

535.23.08

8670. DESIGN AND CONSTRUCTION OF A BLACKBODY AND ITS USE IN THE CALIBRATION OF A GRATING SPECTRORADIOMETER. G.T.Lalos, R.J.Corruccini and H.P.Broida.
Rev. sci. Instrum., Vol. 29, No. 6, 505-9 (June, 1958).

A blackbody was constructed of graphite which could be inductively heated in an atmosphere of helium to a maximum temperature of 2700°K. This blackbody was used as a source of radiant energy in the calibration of a grating spectroradiometer. The calibration was made over the spectral range from 2600 to 3800 A in the second order, and from 3300 to 7550 A in the first order. The accuracy of the calibrations was estimated to be of the order of 9% in the regions from 2600 to 2800 A in the second order, and from 7000 to 7550 A in the first order, and of 5% in the regions from 2800 to 3800 A in the second order, and from 3300 to 7000 A in the first order.

A.

535.24

8671. FLUX THROUGH A SLIT VIBRATING SINUSOIDALLY. E.W.Marchand.
J. Opt. Soc. Amer., Vol. 48, No. 10, 760 (Oct., 1958).

A slit of finite width d oscillates with amplitude D in front of a detector. The time-averaged flux received at different points of the detector is calculated as a function of d and D. W.T.Welford

535.24

8672. AVERAGE DISTRIBUTION OF LIGHT FLUX BY A NARROW SLIT VIBRATING IN AMPLITUDE-MODULATED HARMONIC MOTION. H.Lamport.
J. Opt. Soc. Amer., Vol. 48, No. 10, 760-1 (Oct., 1958).

A narrow slit vibrates in front of a detector and the amplitude of the vibration is modulated at some much lower frequency. The average flux at different modulation amplitudes is calculated as a function of position on the detector. W.T.Welford

535.245

8673. LIMITING DISTANCE FOR PHOTOMETRY OF REAL IMAGES OF LIGHT SOURCES. H.J.Hentschel and O.Reeb.
Lichttechnik, Vol. 10, No. 7, 370-2 (July, 1958). In German.

In the photometry of high intensity light sources it is often the practice to form a real image of the source by means of an optical system and to measure the luminous intensity of selected areas of this image. Discusses (a) the relation between the luminous intensity of the image and that of the corresponding area of the source; and (b) the conditions which must be fulfilled if the image is to be measured to a stated accuracy. J.W.T.Walsh

535.317.6

8674. OPTICAL ABERRATION COEFFICIENTS. III. THE COMPUTATION OF THE TERTIARY COEFFICIENTS. H.A.Buchdahl.
J. Opt. Soc. Amer., Vol. 48, No. 10, 747-56 (Oct., 1958).

For Pt II, see Abstr. 5754 (1958). In the course of the design of an optical system a knowledge of higher order aberration coefficients and of the contributions thereto by the individual surfaces is of great value. The present paper provides a computing scheme for the full set of tertiary (and of course primary and secondary) monochromatic aberration coefficients of symmetrical optical systems composed of spherical surfaces. This particular scheme is intended for use with ordinary desk calculating machines, and comprises only 192 entries of the usual kind per surface. The method of construction of the scheme is discussed, and a complete numerical example provided. The checks used to ensure the correctness of the scheme at the same time test the correctness of certain long sets of equations contained in the author's monograph on optical aberration coefficients; and one misprint in them was thus discovered. This is corrected here. A new nomenclature for higher order aberrations is proposed.

A.

535.317.6

8675. OPTICAL ABERRATION COEFFICIENTS. IV. THE COEFFICIENT OF QUATERNARY SPHERICAL ABERRATION. H.A.Buchdahl.
J. Opt. Soc. Amer., Vol. 48, No. 10, 757-9 (Oct., 1958).

The computation of the tertiary aberration coefficients of symmetrical optical systems composed of spherical surfaces had been fully dealt with previously. To show that it is quite feasible to calculate in the same way coefficients of still higher order, the present paper deals with the coefficient of quaternary (i.e. ninth order) spherical aberration. The intrinsic contributions are first brought into a remarkably simple form. Thereafter the required iteration formula is developed, and, by way of example, the actual computations are carried out for a certain triplet, the computing scheme in this instance being treated as an appendix to that for the set of tertiary coefficients.

A.

535.325 : 536.48

REFRACTIVE INDEX OF He^4: SATURATED VAPOUR. See Abstr. 7866

535.33.07

8676. ELECTRONIC-RECORDING, TIME-RESOLVING SPECTROMETER. P.Gloersen.
J. Opt. Soc. Amer., Vol. 48, No. 10, 712-16 (Oct., 1958).

A photoelectric means for recording an extended spectral region as a function of time was developed. With this method, the recording procedure imposes no limitations on the time resolution other than that defined by the minimum detectable energy. The optical portion of the device, which includes the time-resolving mechanism, is very similar to a conventional photographic time-resolving spectrograph. However, the photographic plate was replaced by a television camera which is used in much the same way. In fact, direct analogies can be drawn between the photographic plate and the storage surface of the television camera tube and also between the photographic developer and the scanning electron beam in the camera tube. The method is capable of sensitivities of the order of 10^3 times those available with Tri-X film in the visible. In addition, the usual cumbersome photographic calibration procedures are avoided since intensities are recorded as vertical deflections, yielding records similar in appearance to those obtained from strip chart recorders.

A.

535.332

8677. SPECTRAL LINE PROFILES IN THERMALLY EXCITED HELIUM. H.Wulff.
Z. Phys., Vol. 150, No. 5, 614-31 (1958). In German.

Experiments were carried out with 1000 A transient arcs in helium (temp. ~ 30 000°C, electron density ~ $10^{16}/cm^3$); spectroscopic observations were made of the series limit continua in various series, from which electron densities were deduced using the Inglis–Teller theory, and Stark widened lines (4922, 4471 and 4026 A). From the latter, electron densities were also computed. Further experimental data are given for the lines 3889, 5016, 3964, 4713, 4121 and 5048 A of helium. J D.Craggs

535.332

8678. SPECTRA OF ARGON, OXYGEN, AND NITROGEN MIXTURES. C.D.Cooper and M.Lichtenstein.
Phys. Rev., Vol. 109, No. 6, 2026-8 (March 15, 1958).

The green bands which are associated with the 5577 A oxygen line for oxygen and argon mixtures were obtained with an ozonizer discharge tube. Nitrogen was found to greatly enhance the intensity of the green if the discharge tube was maintained at the temperature of liquid air. Spectrograms with a plate factor of 1.9 A/mm partially resolve the rotational structure of the overlapping vibrational bands. A 20 cm^{-1} difference appears between several bands. It is assumed that this spectrum results from loosely bound molecular states which may be represented by $A(^1S_g)O(^1S_g)$ and $A(^1S_g)O(^1D_g)$. There are no bands associated with the 2972 A line. The 5577 A line and associated bands were observed in a d.c. arc through 3 atm of commercial argon. A green glow is found to dominate the spectrum of an oxygen and nitrogen mixture if the discharge is maintained at −192°C. This spectrum consists of the 5577 A line, a continuum, and a few diffuse bands.

A.

535.333

8679. INFRARED EMISSIVITY OF NO IN HIGH-TEMPERATURE AIR. R.G.Breene, Jr.
J. chem. Phys., Vol. 29, No. 3, 512-16 (Sept., 1958).

The emissivity treatment developed by Mayer (Abstr. 1599/1958) is modified for specific application to rotation–vibration spectra. In order to obtain the oscillator strengths requisite to such a calculation, an earlier developed calculation of the vibrational matrix elements of NO is utilized. The emissivity of an equilibrium distribution of NO in high-temperature air is calculated for one layer thickness and several values of temperature and pressure. This emissivity calculation was programmed on the I.B.M. 704 electronic data processing machine.

A.

535.333 : 537.525

SPECTROSCOPIC INVESTIGATION OF A POWERFUL PULSED DISCHARGE IN HYDROGEN. See Abstr. 8005

535.333

8680. CLASSIFICATION OF THE SPECTRA OF SOLIDS AND THEIR ORIGIN BY EXCITATION.
S.Nikitine, R.Reiss and M.Sieskind.
C.R. Acad. Sci. (Paris), Vol. 246, No. 25, 3439-42 (June 23, 1958).

In French.

Three kinds of emission spectra of solids were described. The spectra of the first class correspond to transitions with k = 0 to excited states S, the spectra of the second class to transitions to excited states P. The spectra of the third class have not been interpreted theoretically. C.Turner

535.338.332 : 539.18

8681. SEPARATION AND IDENTIFICATION OF OVERLAPPING HYPERFINE STRUCTURE COMPONENTS: APPLICATION TO MERCURY RESONANCE RADIATION.
P.L.Sagalyn, A.C.Melissinos and F.Bitter.
Phys. Rev., Vol. 109, No. 2, 375-80 (Jan. 15, 1958).

A new technique was developed for the separation of overlapping lines in the h.f.s. pattern of atomic energy levels. By a combination of magnetic scanning and double resonance it was possible to resolve the 2537 A line of mercury. By plotting the maxima of the microwave resonance v. scanning field, a separate curve was obtained for each F-level of the odd isotopes. In the same way a curve showing the maxima of the resonance signals from all of the even isotopes was obtained. Information about the odd isotopes obtained from a 3000 Mc/s "double-resonance" experiment is also reported. Only minor disagreements with existing data were observed. A.

535.338.334 : 537.56

8682. STATISTICAL BROADENING OF SPECTRAL LINES EMITTED BY IONS IN A PLASMA. M.Lewis and H.Margenau.
Phys. Rev., Vol. 109, No. 3, 842-5 (Feb. 1, 1958).

The Holtsmark theory of line broadening omits the factor $\exp(-V_{ij}/kT)$ in the evaluation of probabilities, V_{ij} being the Coulomb interaction between the ith and the jth ions. This leads to serious errors in the wings of a line where frequency shifts arise from close encounters which are inhibited by the Boltzmann factor. In Pt I of the present article a consistent binary approximation to the line shape is given, the assumption being made that only a single perturber is involved in a collision. Pt II treats the case of many particles, retains V_{ij} for all perturbers j interacting with a single radiating ion i, but ignores forces between the perturbers themselves. Comparison is made with other treatments. A.

535.34

8683. LIQUID–GAS INFRARED INTENSITIES, PRESSURE-INDUCED ABSORPTION, AND THE TEMPERATURE DEPENDENCE OF INFRARED INTENSITIES IN LIQUIDS. W.B.Person.
J. chem. Phys., Vol. 28, No. 2, 319-22 (Feb., 1958).

The paper by Polo and Wilson (Abstr. 1049/1956) eliminates the apparent discrepancy between the equations given for the relationship between intensities of a compound in the gas phase and the intensities in the liquid phase. However, the experimental tests of this equation have not been conclusive. This paper applies their equation to the pressure-induced absorption of methane, and to the temperature dependence of the integrated intensities of liquid cyclohexanone and liquid benzene. The treatment of Polo and Wilson is extended to give an equation which is valid for solutions. In all cases, qualitative agreement is obtained between experiment and calculation and it would seem that the effect of index of refraction on the intensity accounts for a significant part of the changes observed. The agreement for benzene and for the pressure-induced absorption of methane is excellent. A.

535.34

8684. PHASE CHANGES AND SPECTRAL SHIFTS.
W.W.Robertson and S.E.Babb, Jr.
J. chem. Phys., Vol. 28, No. 5, 953-5 (May, 1958).

The absorption spectrum of benzene was obtained in the diluents carbon dioxide, ethylene, and ethane over a wide range of densities both above and below the critical temperatures. The red spectral shifts are linear functions of the density throughout the density range for ethylene and ethane and are independent of the state of the diluent. A break in the linear wavelength–density curve occurs at high densities of carbon dioxide. These results support the view that gases and liquids are essentially the same thing in those cases where specific interactions are not involved and suggest further that the radial distribution function remains constant from low to high densities of gas and into the liquid state. A.

535.34.07

8685. APPARATUS FOR MEASUREMENTS ON HORIZONTALLY ARRANGED OBJECTS BY MEANS OF A LEITZ INFRARED SPECTROGRAPH AND ITS APPLICATION IN PRACTICE.
H.G.Krüger and K.Maennchen.
Z. Phys., Vol. 151, No. 1, 1-4 (1958). In German.

Describes an apparatus equipped with toroidal mirrors by means of which the path of the measuring radiation is first deflected upwards and then brought back into the original direction, and discusses the use of this apparatus with a heating stage (during the heating process the foils are measured first in solid and then in liquid state). As an example of practical use the authors give a number of measurements relating to the effect of temperature on the rocking oscillation of the CH_2 group in polyethylene.

F.Lachman

535.343 : 539.12

THE POSITRONIUM ATOMIC SPECTRUM. See Abstr. 8969

535.343

8686. THE HYPERFINE STRUCTURE OF THE INDIUM HYDRIDE BANDS. H.Neuhaus.
Z. Phys., Vol. 150, No. 1, 4-9 (1958). In German.

The visual bands are observed with higher resolution. The R(0), Q(1) and P(2) lines of the (0-0), $^3\Pi_1$-$X^1\Sigma^+$ band are split into three hyperfine structure components. A new band system $^1\Pi$-$X^1\Sigma^+$, whose rotation lines show no hyperfine structure, is observed and analysed. The hyperfine structure is interpreted in terms of a nuclear magnetic moment. G.F.Lothian

535.343 : 539.2

8687. INTRINSIC OPTICAL ABSORPTION IN GERMANIUM–SILICON ALLOYS. R.Braunstein, A.R.Moore and F.Herman.
Phys. Rev., Vol. 109, No. 3, 695-710 (Feb. 1, 1958).

The intrinsic optical absorption spectrum for the germanium–silicon alloy system was measured as a function of temperature and composition. Over the entire composition range the absorption near the threshold ($K < 100$ cm^{-1}) exhibits a temperature dependence which is characteristic of phonon-assisted indirect electronic transitions. There appears to be no temperature-independent component of the absorption attributable to disorder-assisted transitions. When the phonon contribution to the absorption is explicitly taken into account, as in a Macfarlane-Roberts type analysis (Abstr. 4654, 7845/1955), the experimental data yield an equivalent phonon temperature which varies from 270 ± 20°K for pure Ge to 550 ± 50°K for pure Si, with most of the variation occurring in the middle of the composition range. The composition dependence of the derived energy gap shows an abrupt change in slope at about 15 atomic per cent Si. This is due to a switch from a Ge-like ([111]) to a Si-like ([100]) conduction band structure. The onset of direct electronic transitions (10^2 cm$^{-1} < K < 10^4$ cm^{-1}) was observed as a function of composition in the Ge-rich alloys. The data show that the [000] conduction band minimum moves more rapidly than the [111] minima as Si is added to Ge. In an attempt to account for the observed variation of the phonon equivalent temperature with composition, certain lattice vibrational modes were computed on the basis of a number of simplified models. The one which gives the most realistic results emphasizes the presence of atoms of different masses and some short-range order in the alloy lattice. A.

535.343 : 537.312.5

OPTICAL TRANSMISSION OF ACTIVATED AND UNACTIVATED SINGLE CRYSTALS OF ZnS. See Abstr. 7972

535.343

8688. VIBRATIONAL SPECTRUM OF NICKEL CARBONYL.
L.H.Jones.
J. chem. Phys., Vol. 28, No. 6, 1215-19 (June, 1958).

The infrared absorption spectrum of $Ni(CO)_4$ was studied in the liquid and gaseous states. As a result of the observations certain frequency assignment changes are made. The most probable assignment of fundamental frequencies appears to be 2128 and 381 for the A_1 species; 461 and 79 for the E species; 2057, 459, 422, and 79 for the F_2 species; and 300 cm^{-1} for the F_1 species. Using these values a normal coordinate treatment was carried out. Though the solution is not unique, $F_{CO} = 17.3 \pm 0.4$ millidyne/A and $F_{NiC} \cong 2.1$ millidyne/A. A.

535.343

8689. INFRARED ABSORPTION SPECTRA OF CHROMYL FLUORIDE AND CHROMYL CHLORIDE. W.E.Hobbs.
J. chem. Phys., Vol. 28, No. 6, 1220-2 (June, 1958).

The spectra of gaseous chromyl fluoride and gaseous chromyl chloride were investigated. The region investigated for chromyl fluoride was 2 to 36 μ while that for chromyl chloride was 2 to 25 μ. Six fundamental and nineteen first overtone or binary combination bands were observed in the spectrum of chromyl fluoride, the fundamental bands being located at 274, 304, 727, 789, 1006, and 1016 cm^{-1}. The observed transitions are assigned on the basis of a tetrahedral model of C_{2v} symmetry. From the observed spectrum it was possible to estimate the probable positions of the three remaining fundamental bands. The observed spectrum of chromyl chloride included

four fundamental bands located at 475, 499, 990, and 1000 cm^{-1} and one first overtone or binary combination band located at 1980 cm^{-1}. A.

535.343

8690. POLARIZED INFRARED SPECTRUM OF POTASSIUM THIOCYANATE. L.H.Jones.
J. chem. Phys., Vol. 28, No. 6, 1234-6 (June, 1958).

The polarized infrared spectrum of crystalline potassium thiocyanate is reported. This additional information necessitates certain assignment changes in the observed vibrational frequencies from those previously reported. The vibrational spectrum now appears quite complete and in agreement with the crystal structure report of Klug. A.

535.343 : 535.37

SPECTRA OF "CEMENT" PHOSPHORS. See Abstr. 7829

535.343 : 537.311.33

INFRARED STUDIES ON GROUP III-V INTERMETALLIC COMPOUNDS. See Abstr. 7931

535.343 : 539.19

VIBRATIONAL SPECTRUM OF METAL-CYANIDE COMPLEXES IN THE SOLID STATE. $K_3Cu(CN)_4$. See Abstr. 9081

535.343

8691. SPECTROSCOPIC STUDY OF THE MONOTROPIC FORMS OF MONOCHLORACETIC ACID.
J.R.Barceló, M.P.Jorge and C.Otero.
J. chem. Phys., Vol. 28, No. 6, 1230-4 (June, 1958).

Monochloracetic acid ($CClH_2$-COOH) is a trimorphic substance. Only one of the three forms is stable, viz.: the α form; whereas the β and γ forms are metastable. The infrared spectrum of the forms α and β was studied; that of the γ form was not studied because of its extreme instability. It is seen that the spectrum of the α form is different from that of the β form. The fundamental frequencies of monochloracetic acid are assigned, bearing in mind the assignments made by the present authors in another paper for di- and trichloracetic acids. This assignment makes it possible to determine that the displacements which are observed when passing from form α to β chiefly affect the frequencies bound up with the carboxyl group and more especially those in the OH group. This was confirmed by the preparation of the deuterated derivatives which likewise present themselves in α and β forms, the same relative differences in frequencies being observed. It is inferred from this study that the two crystalline forms differ in the structure of the intermolecular dimers (or polymers). The α form is the conventional dimer with two hydrogen bonds. In the β form this intermolecular bond is probably not the double hydrogen bond, since the OH groups show a greater mobility. A.

535.343

8692. VIBRATIONAL SPECTRA OF THE CRYSTALLINE METHYL HALIDES. D.A.Dows.
J. chem. Phys., Vol. 29, No. 3, 484-9 (Sept., 1958).

The infrared spectra of the crystalline methyl halides, CH_3Cl, CH_3Br, and CH_3I, at 80°K are reported. Information on gas–solid frequency shifts, band splittings due to site symmetry and intermolecular coupling, librational frequencies, and relative intensities of band components is summarized and compared. Relative intensities of band components are not in agreement with the predictions of the "oriented gas" model. Most other observations are consistent with the assumption of isomorphism between the crystal structures of the three compounds, but the data are not sufficient to prove the isomorphism. A.

535.343

8693. MICROWAVE SPECTRUM OF METHYL DIFLUOROSILANE.
J.D.Swalen and B.P.Stoicheff.
J. chem. Phys., Vol. 28, No. 4, 671-4 (April, 1958).

The microwave spectra of five isotopic species of methyl difluorosilane (CH_3SiHF_2) were observed. From the rotational constants, the following structural parameters are determined

$r_{FF} = 2.541 \pm 0.001$ A	
$r_{SiC} = 1.833 \pm 0.002$ A	$\angle FSiF = 106°44' \pm 30'$
$r_{SiF} = 1.583 \pm 0.002$ A	$\angle CSiH = 116°10' \pm 1°$
$r_{SiH} = r_{SiD} = 1.474 \pm 0.005$ A	$\angle FSiC = 109°52' \pm 30'$
$r_{CH} = 1.09$ A (assumed)	$\angle HCH = 108°$ (assumed).

A dipole moment of 2.11 debye was obtained from Stark effect measurements. The hindered internal rotation of the methyl group splits some of the rotational lines into doublets with spacings from 0.5 to 2.9 Mc/s. An analysis of the doublet splitting in three of the isotopic species gives a barrier height of 439 cm^{-1} (1255 cal/mole) hindering internal rotation. A.

535.343.07

8694. EXPERIMENTAL EVALUATION OF THE OXYGEN MICROWAVE ABSORPTION AS A POSSIBLE ATOMIC FREQUENCY STANDARD. J.M.Richardson.
J. appl. Phys., Vol. 29, No. 2, 137-45 (Feb., 1958).

A microwave absorption line of O_2 near 60 000 Mc/s was experimentally investigated as a possible atomic frequency standard of high precision. Theoretical design, actual design, and results for an oxygen microwave spectrometer for use either in observing the line frequency or as a discriminator in a frequency control loop synchronizing an oscillator are described. Essential characteristics are the rate of change of spectrometer output signal with frequency and the output noise level. General expressions for these quantities for a wide range of experimental arrangements are obtained, and may be used to predict the attainable frequency precision. Characteristics in complete agreement with the theoretical values, capable of an accuracy of less than 1 part in 10^9, were experimentally observed with relatively crude apparatus. These characteristics involved line widths of around 560 kc/s and signal/noise ratios of 83 dB. Improvement by a few orders of magnitude can be confidently expected by engineering refinements. An additional result was close confirmation of the theoretical absolute intensity of the $N_+ = 7$ line and a precision measurement of its frequency as (60 434.70 ± ± 0.05 Mc/s. A.

535.345 : 538.221

8695. OPTICAL PROPERTIES OF SEVERAL FERRIMAGNETIC GARNETS. J.F.Dillon, Jr.
J. appl. Phys., Vol. 29, No. 3, 539-41 (March, 1958).

All of the ferrimagnetic garnets studied to date were found to be transparent to visible light down to wavelengths of about 5200 A. Thin sections (e.g. 0.005 cm) of yttrium, erbium, and gadolinium iron garnets were examined to determine the absorption and the specific Faraday rotation through that part of the visible spectrum where they transmit light. These measurements were made at temperatures down to 4.2°K. They are interpreted as giving information on electronic energy levels. A magnetic birefringence and a circular dichroism have been observed. The Faraday rotation permits observation of the domain structure in these crystals at any temperature below the Curie point. Possible microwave-optical experiments are discussed briefly. A.

535.345 : 541.14

8696. ABSORPTION AND IONIZATION COEFFICIENTS OF ETHYLENE OXIDE. A.Lowrey, III and K.Watanabe.
J. chem. Phys., Vol. 28, No. 2, 208-10 (Feb., 1958).

Total absorption coefficients of ethylene oxide vapour were obtained in the region from 1050 to 1850 A by a photoelectric method, and photoionization yields were measured in the region from 1050 to 1190 A. A reassignment of the absorption bands in the region from 1180 to 1480 A yielded a Rydberg series which converged to 10.565 eV, a value in agreement with the ionization potential obtained by photoionization measurements. A second Rydberg series was found to converge to a vibrationally excited ionic ground state. A.

535.345

8697. SCHUMANN–RUNGE OXYGEN ABSORPTION IN SHOCK-HEATED AIR. W.H.Wurster, C.E.Treanor and H.S.Glick.
J. chem. Phys., Vol. 29, No. 1, 250-1 (July, 1958).

A synchronized xenon flash lamp and shutter were used to photograph absorption by O_2 at ½ to 4 atm between 3000 and 6000 °K, using incident and reflected shock waves. At 4380 °K and 4 atm, the half-width of the lines is somewhat less than 1 A and the absorption coefficient varies from 1.2 to 3.5 cm^{-1}. A.G.Gaydon

535.345 : 537.311.33

8698. INTRINSIC OPTICAL ABSORPTION AND THE RADIATIVE RECOMBINATION LIFETIME IN PbS. W.W.Scanlon.
Phys. Rev., Vol. 109, No. 1, 47-50 (Jan. 1, 1958).

The intrinsic optical absorption spectrum of PbS crystals was measured. The absorption coefficients range from about 10 cm^{-1} to 10^5 cm^{-1} giving continuous data through the band edge. At 300°K the data indicate a direct transition energy of 0.41 eV, and an indirect transition energy of 0.37 eV. The radiative recombination lifetime for PbS calculated from the absorption data is 63 μsec at 300°K. A.

535.345 : 537.311.33

8699. OPTICAL PROPERTIES OF HEXAGONAL ZnS SINGLE CRYSTALS. W.W.Piper, D.T.F.Marple and P.D.Johnson.
Phys. Rev., Vol. 110, No. 2, 323-6 (April 15, 1958).

The optical transmission of hexagonal zinc sulphide crystals was measured in the spectral range from 0.32 to 15 μ. From the

spacing of interference maxima, the dependence of index of refraction on wavelength was determined. Measurements of the effects of temperature from 20°C to 120°C and of pressure up to 1700 atm on the width of the forbidden energy band indicate an increase in band gap of 9×10^{-6} eV/atm with pressure and a decrease of 7×10^{-4} eV/C° with temperature for both ordinary and extraordinary rays. Approximately one-fifth of the shift with temperature is the result of dilation of the lattice. The origin of the larger portion of the shift is discussed. A.

535.345 : 537.312.5

8700. OPTICAL ABSORPTION AND PHOTOEMISSION OF BARIUM AND STRONTIUM OXIDES, SULFIDES, SELENIDES, AND TELLURIDES. R.J.Zollweg.
Phys. Rev., Vol. 111, No. 1, 113-19 (July 1, 1958).

Considerable structure was observed at the intrinsic optical absorption edge of annealed films of BaO, BaS, BaSe, BaTe, SrO, SrS, SrSe, and SrTe at −160°C. Photoemission measurements allow an estimate to be made of the energy separation between the top of the valence band and the vacuum level. A.

535.345 : 537.311.33

INFRARED SPECTRUM OF SILICON. See Abstr.7960

535.345 : 539.2

INFRARED ABSORPTION AND OXYGEN CONTENT IN SILICON. See Abstr. 8439

535.345 : 539.219

INFRARED ABSORPTION OF SILICON SINGLE CRYSTALS IN RELATION TO OXYGEN CONTENT. See Abstr. 9138

535.371 : 537.312.5 : 621.383.27 : 621.387.464

8701. SPECTRAL EFFECTS IN THE COMPARISON OF SCINTILLATORS AND PHOTOMULTIPLIERS.
R.K.Swank, W.L.Buck, F.N.Hayes and D.G.Ott.
Rev. sci. Instrum., Vol. 29, No. 4, 279-84 (April, 1958).

Photomultiplier evaluation of scintillation performance is considered in the light of its marked dependence on spectral shape effects in the emission spectrum of the scintillator, in photon absorption of cell, reflector and photomultiplier window, and in the photoelectric conversion process. Relative pulse-height data indicating gross differences in spectral sensitivity are presented for a group of 132 photomultipliers (types 6292 and 6342). A fluorescent converter for measuring the quantum output of liquid scintillators is described. Six scintillator solutions with fairly evenly spaced mean emission wavelengths from 3360 to 4660 A are evaluated for relative pulse-height and relative photon output. Suggestions are presented for desirable methods for measuring the performance of scintillators. A.

535.372

8702. TRIPLET–SINGLET EMISSION SPECTRA OF SOLID TOLUENE AT 4°K AND 77°K AND IN E.P.A. SOLUTION AT 77°K.
Y.Kanda and H.Sponer.
J. chem. Phys., Vol. 28, No. 5, 798-806 (May, 1958).

Phosphorescence of toluene was studied at 4°K and 77°K in its solid phases (crystalline and amorphous) and in solid solution (E.P.A.) at 77°K. The spectrum of the crystal at 4°K (3460-4530 A) consists of sharp bands, and weaker diffuse bands which resemble in arrangement the rigid glass spectrum at 77°K. This emission has a lifetime of about 8 sec. The spectrum of solid toluene at 77°K (3950-4900 A) has broad diffuse bands, and an estimated lifetime of $\sim 10^{-2}$-10^{-3} sec. Its vibrational structure differs from that of the spectra at 4°K and in E.P.A., but resembles much the structure of the phosphorescence spectrum of benzaldehyde. The origin of the various spectra and the differences between them are discussed. The suggestion is made that benzaldehyde is produced photochemically and that its spectrum appears by a process of sensitization. A.

535.376 : 539.1.07

8703. APPLICATION OF LUMINESCENCE CHANGES IN ORGANIC SOLIDS TO DOSIMETRY. J.H.Schulman, H.W.Etzel and J.G.Allard.
J. appl. Phys., Vol. 28, No. 7, 792-5 (July, 1957).

The degradation of photoluminescence in anthracene and in naphthalene was studied under gamma-ray and electron irradiation over the range 3×10^5 to 2×10^8 rep. For both materials the variation of brightness with Co^{60} gamma-ray dose D (in rep.) may be represented by $(I/I_0) = (1 + AD)^{-1}$, where $A = 8.5 \times 10^{-7}$ for anthracene and 14×10^{-7} for napthalene. Irradiation also produces a radiophotoluminescence in naphthalene, with emission in the visible spectral region. Both the degradation and radiophotoluminescence are stable with time at room temperature. The employment of these effects for dosimetry is discussed. A.

535.376

8704. ROLE OF METASTABLE STATES IN THE PRODUCTION OF SCINTILLATIONS IN THE RARE GASES BY ALPHA PARTICLES.
P.Avivi and S.G.Cohen.
Phys. Rev., Vol. 108, No. 4, 972-3 (Nov. 15, 1957).

The lifetimes of alpha-ray induced scintillations in the rare gases (Xe, Kr, A, and Ne) were measured as a function of pressure. The lifetimes were found to be inversely proportional to the pressure. It is shown that the major part of the scintillations are in the far ultraviolet below 1250 A. It is suggested that these scintillations result from the destruction of metastable excited states of the rare gas ions. A.

535.376

8705. RESPONSE OF CsI(Tl) CRYSTALS TO ENERGETIC PARTICLES. S.Bashkin, R.R.Carlson, R.A.Douglas and J.A.Jacobs.
Phys. Rev., Vol. 109, No. 2, 434-6 (Jan. 15, 1958).

The light output of thallium-activated caesium iodide was measured as a function of bombarding energy for protons (240 keV $\leq E_p \leq 2550$ keV), alpha-particles (980 keV $\leq E_\alpha \leq$ ≤ 4920 keV), and C^{12} ions (320 keV $\leq E_C \leq 1850$ keV). The relation of the light output to the particle energy is approximately linear in these energy ranges. The light outputs for different particles of the same energy are in the ratio $p : \alpha : C^{12} = 1.00 : 0.59 : 0.35$. Saturation effects account for these results. The resolution varies inversely as the square root of the light output. A.

535.376 : 778.34 : 539.12

PARTICLE RESOLVING POWER OF FLUORESCENT SCREENS. See Abstr. 8196

535.376 : 537.533.8

EXCITATION OF SHORT INFRARED PULSES WITH HIGH REPETITION RATE BY ELECTRON BOMBARDMENT OF CUPROUS OXIDE. See Abstr. 8817

535.377 : 539.2

8706. F AND V CENTERS THERMOLUMINESCENT RECOMBINATION. G.Bonfiglioli, P.Brovetto and C.Cortese.
Phys. Rev. Letters, Vol. 1, No. 3, 94-5 (Aug. 1, 1958).

Thermoluminescence in NaCl containing F centres is treated as a second-order process. An activation energy of 0.72 eV was obtained together with the transition probabilities to three luminophor centres, which were identified as V centres. J.Franks

535.378 : 539.6

8707. RADIATION DUE TO ADHESIVE BREAKS BETWEEN HIGH POLYMERS AND GLASS. R.C.Williams.
J. appl. Phys., Vol. 28, No. 9, 1043-8 (Sept., 1957).

Adhesive breaks (separation at the interface) were obtained between high polymers and glass that require no external mechanical equipment to induce break. Visible light is emitted during these breaks. The polymers are contained in Pyrex vials that are immersed in a 125°C oil bath. After a nominal polymerization period, the polymers are removed from the bath. The adhesive breaks occur while the polymer-glass system is cooling toward room temperature. The properties of the light due to these breaks were studied with a photomultiplier, pulse-height discriminator combination. The wavelength of the light was measured spectrographically and the internal temperature of the polymers was monitored during the cooling process. A.

535.379 : 541.126

AIR AFTERGLOW AND KINETICS OF SOME REACTIONS OF ATOMIC OXYGEN. See Abstr. 9159

535.39

8708. THE TEMPERATURE DEPENDENCE OF THE OPTICAL CONSTANTS OF LiF IN THE RANGE OF THE INFRARED RESIDUAL RAY BAND. G.Heilmann.
Z. Phys., Vol. 152, No. 3, 368-83 (1958). In German.

The temperature dependence of the optical constants, n and k, were determined from reflection measurements in the ranges 15-36 μ and 20-600°C. k decreased with temperature in the immediate neighbourhood of the eigenfrequency (33 μ); the secondary maximum of k at 18 μ decreased with temperature, but much less rapidly than the principal maximum associated with the eigenfrequency. The expected shift of eigenfrequency to longer wavelengths with increasing temperature was not observed. An estimate is made of the temperature dependence of the damping of the fundamental vibration. B.T.M.Willis

535.39 : 539.2

OPTICAL PROPERTIES OF DIAMOND TYPE CRYSTALS. See Abstr. 8426

535.392

8709. GLOSS SCALE FOR PAINT SURFACES. M.C.Boshoff.
J. Opt. Soc. Amer., Vol. 48, No. 10, 741-6 (Oct., 1958).

A system is described whereby just noticeable differences in gloss can be expressed in terms of differences in specular luminance factors. The number of just noticeable gloss differences was determined graphically for paint specimens with specular luminance factors varying from 0.5 to 40.0. For the specification of gloss a system is proposed in which gloss units are equivalent to just noticeable gloss differences. A.

535.399

8710. OPTICAL CONSTANTS OF GERMANIUM: 3600 A TO 7000 A. R.J.Archer.
Phys. Rev., Vol. 110, No. 2, 354-8 (April 15, 1958).

The optical constants of single-crystal Ge, obtained from the ellipticity of reflected polarized light, exhibit two maxima. The real part of the index of refraction has maxima of 5.66 at 6000 A and 4.24 at 3900 A. The extinction coefficient has a maximum of 2.3 at 4900 A and another, just outside the range of the measurements, at about 3100 A with a value of about 3.3. The data are consistent with the Kramers–Kronig relations, and it is concluded that the absorption curve has only two maxima and rapidly approaches zero beyond 2500 A. There are significant differences between the five published measurements of the optical constants of Ge in the visible. Of the two previous works that used single-crystal material, the present results disagree with one and agree with the other which, however, covers over 700 A of the visible. A.

535.41

8711. ON THE THEORY OF INTERFERENCE MODULATION IN TWO-BEAM INTERFEROMETRY. L.Genzel and R.Weber.
Z. angew. Phys., Vol. 10, No. 3, 127-35 (March, 1958). In German.

If the path-difference in a two-beam interferometer illuminated with a continuum is varied simple-harmonically in time the interference maxima for the different wavelengths will appear with different frequencies. Thus a detector which is sensitive to the whole continuum can be connected to a tuned amplifier and the response will correspond to a chosen wavelength component. This principle of interference modulation is applied to a laminar reflection grating used in the far i.r. region with variable path difference between the laminae. W.T.Welford

535.412

8712. ON THE INTERFERENCE FRINGES OUTSIDE THE GEOMETRICAL SHADOW OF A STRAIGHT WIRE.
B.Marković and R.Draščić.
Period. math.-phys. astron. (Zagreb), Vol. 13, No. 1, 57-63 (1958). In French.

The monochromatic interference fringes are discussed in relation to the diffraction fringes from a half-plane. Photographs illustrate the appearance of the interference fringes with different widths of illuminating slit. B.T.M.Willis

535.417

8713. ADVANCES IN PERFORMANCE AND APPLICATIONS OF THE FABRY–PEROT INTERFEROMETER. A.Steudel.
Naturwissenschaften, Vol. 44, No. 8, 249-55 (1957). In German.

This is a general survey of recent improvements which have been published elesewhere. The importance of absorption of the reflecting film is discussed. Dielectric multilayers are surveyed and their reflectivity as a function of wavelength is discussed. Materials discussed include single sulphide–cryolite and $PbCl_2$–MgF_2. Registering photoelectric Fabry–Perot spectrometers are surveyed. A comprehensive literature is reviewed. S.Tolansky

535.42 : 548.733

CRITICAL METHOD OF FOCUSING AN OPTICAL DIFFRACTOMETER. See Abstr. 8523

535.421

8714. THEORY OF THE ECHELETTE GRATING. II.
J.H.Rohrbaugh and R.D.Hatcher.
J. Opt. Soc. Amer., Vol. 48, No. 10, 704-9 (Oct., 1958).

For Pt I, see Abstr. 2013 (1956). Simplified formulae for the intensity distribution among the orders of an echelette grating are derived from the Green's function method, and compared with previous expressions. The application to special types of mounts and the possibility of using gratings as filters is discussed. A.

535.421

8715. THEORY OF THE ECHELETTE GRATING. III.
J.H.Rohrbaugh, C.Pine, W.G.Zoellner and R.D.Hatcher.
J. Opt. Soc. Amer., Vol. 48, No. 10, 710-11 (Oct., 1958).

Calculated and measured relative intensities for three orders appearing simultaneously in the spectrum of an echelette grating at λ 4.211 mm are obtained in both polarizations. Agreement with a calculation based on the Kirchhoff formula is found only for radiation plane polarized with E perpendicular to the grooves. An echelette grating is shown to be a polarizing agent. A.

535.554 : 539.2

8716. BIREFRINGENCE CAUSED BY EDGE DISLOCATIONS IN SILICON. R.Bullough.
Phys. Rev., Vol. 110, No. 3, 620-3 (May 1, 1958).

A calculation is given of the intensity distribution in a beam of plane polarized or circularly polarized infrared light after transmission through a crystal of silicon containing a single-edge dislocation or a simple tilt boundary. It is essential to differentiate between an edge dislocation and the region around the extremum of an inclusion, since both give similar intensity contours, the only difference being one of absolute magnitude. A.

535.557 : 541.64

8717. APPARATUS FOR THE OBSERVATION OF INFRARED STREAMING DICHROISM OF POLYMER SOLUTIONS.
G.R.Bird, M.Parrish, Jr and E.R.Blout.
Rev. sci. Instrum., Vol. 29, No. 4, 305-9 (April, 1958).

A method and apparatus were developed for the quantitative observation of infrared streaming dichroism of solutions of macromolecules. The design, construction, and operation of the apparatus are described in detail. The apparatus consists of a modified standard infrared liquid cell through which the solution is pumped by means of a pair of hypodermic syringes, which are driven in opposition by a pair of cams that provide a constant rate of displacement. The resulting flow is constant except for a reversal in direction at the end of each stroke. The maximum value of the gradient in the cell may be calculated by means of a simple formula. The total volume of the pump and cell is 2.2 cm^3 so that small samples may be measured. Several types of material were measured and a typical result is shown. A.

535.64

8718. CUBE-ROOT COLOR COORDINATE SYSTEM.
L.G.Glasser, A.H.McKinney, C.D.Reilly and P.D.Schnelle.
J. Opt. Soc. Amer., Vol. 48, No. 10, 736-40 (Oct., 1958).

A visually uniform colour coordinate system, based upon simple mathematical formulae, is described. This system resembles the Adams chromatic-value system but replaces the quintic-parabola function with a cube-root function. For colours having reflectances greater than 0.5% the colour spacing obtained agrees with Munsell spacing as closely as the modified Adams system. At lower reflectances an expanded colour spacing over that of the Munsell is provided. The cube-root equations can be solved directly for colour coordinate differences in terms of simple functions of the difference in colorimeter readings or tristimulus values. The computation of colour coordinates in this system is simpler and requires less computational precision than other visually uniform colour coordinate systems. A simple slide rule for computing colour differences in cube-root colour coordinates is described. A modification of the cube-root colour coordinate system which provides nearly perfect representation of the spacing of Munsell colours is described, and the appropriateness of the assumptions required to obtain this behaviour is discussed. A.

535.7

PHYSIOLOGICAL OPTICS. VISION. See under "Medical science. Human physiology". Decimal classification 612.84

535.81 : 778.31 : 532.613.4

MICROCINEMATOGRAPHY OF DYNACTIVE PAIRS OF FLUIDS. See Abstr. 8611

HEAT

536.21 : 537.311.3

8719. CONDUCTION MEASUREMENTS AT LOW TEMPERATURES. J.A.Carruthers.
Nature (London), Vol. 182, 83-5 (July 12, 1958).

Report on a conference held by the Low Temperature Group of the Physical Society on April 11, 1958, at the Institute of Physics, London. Topics dealt with included measurements of the electrical conductivity and Hall effect in n-type indium antimonide from 3° to 300° K by E.H.Puttey and the thermal conductivity of n-type germanium single crystals with Group III impurities from 0.2° to 4.2° K by J.A.Carruthers. The scattering of phonons by a pair of impurity centres was treated theoretically by I.C.Pyle and J.M.Ziman to explain the temperature dependence described in Carruthers' paper.

R.W.Powell gave the results of an extensive series of measurements on the electrical and thermal conductivities of metals at low temperatures. R.T.Webber reviewed work on the magnetoresistance of high-purity copper in strong fields and B.R.Coles discussed the breakdown of Kohler's rule in rhodium as well as Hall coefficient measurements in rhodium, palladium and silver. A short contribution on the theory of galvo-magnetism was given by F.Garcia-Moliner who stressed that slight deviations of the Fermi surface from sphericity can produce large changes in magnetoresistance. L.Mackinnon described experiments on the absorption of ultrasound in normal and superconducting tantalum and mercury and the effect of magnetic fields. H.Montgomery presented the results of measurements on the thermal conductivity of superconducting lead at 1°K and P.M.Rowell those for thermal conductivity of lead alloys and of niobium strained at 4°K. Measurements at helium temperatures of the electrical resistance of molybdenum and tungsten irradiated at 77°K were described by M.W.Thompson and J.N.Lomer gave an account of the determination of dislocation densities in α-brass by lattice thermal conductivity experiments at helium temperatures. Experiments to determine the thermal resistance due to isotopes in crystals of isotopically enriched lithium fluoride were described by R.Berman. F.E.Hoare

536.212.2 : 537.311.33

THERMAL PROPERTIES OF Bi_2Te_3. See Abstr. 7935

536.212.3

8720. LOW-TEMPERATURE THERMAL CONDUCTIVITY IN NEUTRON IRRADIATED VITREOUS SILICA. A.F.Cohen.
J. appl. Phys., Vol. 29, No. 3, 591-3 (March, 1958).

Measurements of the thermal conductivity K of vitreous silica were made at low temperatures before and after fast neutron bombardment. The observed increase of K upon bombardment is in agreement with the prediction of Klemens (Abstr. 7803/1951). Over the exposure range used, K increases approximately linearly with dose to the level used (6×10^{19} n/cm^2) whereas the density appears to have nearly saturated, suggesting that the two properties are not directly related. A possible explanation for the K increase upon bombardment is that the neutron bombardment relieves macroscopic strains. Alternatively, it is possible that bombardment causes an increase in local order in the vitreous material. A.

536.23 : 533.7

8721. THERMAL CONDUCTIVITIES [λ] OF GASES AT LOW PRESSURES. I. MONATOMIC GASES HELIUM AND ARGON. F.G.Waelbroeck and P.Zuckerbrodt.
J. chem. Phys., Vol. 28, No. 3, 523-4 (March, 1958).

These were obtained by simultaneous measurements on three pairs of coaxial cylinders at the same temperature and pressure, each 12 cm long, with (approximately) outer diameter of 2 cm and gaps of 1, 0.43, and 0.215 cm. The temperature difference between cylinders was between ¼-4 deg C. Experimental precautions are mentioned. The results are given graphically, and in a table, with less complete figures for H_2, O_2, air, and CO_2. They are found to satisfy a relation $\lambda = \text{constant}/(1 + K/p)$ predicted theoretically by the work of Mott-Smith. P.Gray

536.23 : 533.7

8722. THERMAL CONDUCTIVITIES [λ] OF GASES AT LOW PRESSURES. II. ROTATIONAL RELAXATION TIMES IN HYDROGEN AND OXYGEN. F.G.Waelbroeck and P.Zuckerbrodt.
J. chem. Phys., Vol. 28, No. 3, 524-6 (March, 1958).

See preceding abstract. λ is measured for H_2 and O_2 in the pressure ranges 0.20-760 and 0.008-2500 mm Hg, and a contribution from heat transfer between rotational and translational states which is identified, is found to occur in 1 in 300 and 1 in 20 collisions respectively. At lower pressures, the active collisions are too few to maintain local equilibrium concentrations, giving a dispersion of the rotational λ. Results are given in two graphs. P.Gray

536.25 : 537.228

8723. ELECTROCONVECTIONAL HEAT TRANSFER IN GASES. S.Arajs and S.Legvold.
J. chem. Phys., Vol. 29, No. 3, 531-6 (Sept., 1958).

Electroconvectional heat transfers were measured in gaseous N_2, CO_2, NH_3, SO_2, and CCl_3F. The results are interpreted and correlated according to the theories of Kronig and of Senftleben and Bültmann. The theoretical predictions of Senftleben and Bültmann concerning the dependence of the electroconvectional heat transfer on the pressure of the gas and the magnitude of the electric field are found to fit the experimental results. A.

536.3

8724. EMISSIVITIES OF METALLIC SURFACES AT 76°K. M.M.Fulk and M.M.Reynolds.
J. appl. Phys., Vol. 28, No. 12, 1464-7 (Dec., 1957).

Heat transport by radiation between surfaces at 300°K and 76°K was measured to evaluate the effective emissivities of a number of technical grade or commercially available metals with unknown metallurgical history. The surface with the lowest total hemispherical emissivity was an unbuffed silver-plated surface. It was found that the emissivity of surfaces was lowest when used without any mechanical working and that the ability to absorb radiant energy varied with the length of time the surface was kept cold, even at a pressure less than 10^{-6} mm Hg, indicating surface contamination by residual gases. A.

536.33.08 : 551.508.2

8725. APPARENT TEMPERATURES OF SOME TERRESTRIAL MATERIALS AND THE SUN AT 4.3 MILLIMETER WAVELENGTHS. A.W.Straiton, C.W.Tolbert and C.O.Britt.
J. appl. Phys., Vol. 29, No. 5, 776-82 (May, 1958).

Describes a 4.3 mm radiometer and measurements made with it of the apparent temperature of various terrestrial materials, the attenuation through the atmosphere and the temperature of the sun. Materials whose apparent temperatures were measured included water, wood, metal, grass, asphalt, gravel and asbestos. Since their apparent temperatures are dependent upon their reflectivity, these data are interpreted in terms of the background reflected by the materials. The attenuation vertically through a clear sky ranged between 1.6 and 2.3 dB. The sun, of optical disk size, was found to be between 10^4 and 1.2×10^4 °K on May 3 and June 17, 1957. A.

536.33.08 : 538.563 : 551.508.25 : 621.317.39

CAPACITOR MICROPHONE AS A RADIATION DETECTOR. See Abstr.9184

536.42

8726. SIZE EFFECT IN HETEROGENEOUS NUCLEATION. N.H.Fletcher.
J. chem. Phys., Vol. 29, No. 3, 572-6 (Sept., 1958).

Assuming a spherical nucleating particle, the effect of particle size and surface properties upon nucleation efficiency is investigated. A general result is derived which is then applied to the condensation, sublimation, and freezing of water on foreign nuclei. The size effect is found to become important in the range 100-1000 A of particle radius. For particles larger than this, nucleation efficiency is substantially independent of size, while for smaller particles the efficiency is very greatly reduced. A.

536.422

8727. IMPROVED INSTRUMENT FOR THE MEASUREMENT OF LINEAR PYROLYSIS RATES OF SOLIDS. M.K.Barsh, W.H.Andersen, K.W.Bills, G.Moe and R.D.Schultz.
Rev. sci. Instrum., Vol. 29, No. 5, 392-5 (May, 1958).

This instrument, which is provided with automatic recording devices, eliminates many of the shortcomings of the earlier prototypes and makes possible the determination of linear rates with a precision of 1%. Important new features include (1) an integral heating element and thermocouple assembly; (2) stainless-steel and Plexiglas construction throughout; (3) heavy, solid-copper electrical-conductor supports for the heating element; and (4) a precision position-sensing potentiometer. The use of cut strands of Plexiglas 55 is recommended for periodic standardization and calibration of the instrument. A.

536.422.1 : 534.222.2

8728. HEAT OF SUBLIMATION OF CARBON [L] AND THE DISSOCIATION ENERGY OF CO [D] BY X-RAY DENSITOMETRY OF SHOCK WAVES. H.T.Knight and J.P.Rink.
J. chem. Phys., Vol. 29, No. 2, 449-50 (Aug., 1958).

Measurements dealt with an 87.5-12.5 mole% Kr—CO mixture for shock velocities in the range 1.65-1.95 mm/μsec. L was found to be 170 kcal/mole and D to be 256 kcal/mole. Thermodynamic equilibrium was assumed and ionization allowed for in the calculations. P.Gray

536.422.1 : 537.583

MEASUREMENT OF INSTANTANEOUS ABSOLUTE BARIUM EVAPORATION RATES FROM DISPENSER CATHODES. See Abstr. 8853

536.422.5

8729. CONDENSATION OF MERCURY VAPOUR ON COOLED SURFACES. H.Walther.
Z. angew. Phys., Vol. 10, No. 6, 272-7 (June, 1958). In German.

The coefficient of condensation of mercury vapour on cooled

nickel surfaces depends upon both their temperature and the duration of their exposure to a jet of mercury vapour. For exposure times of 10 or 15 min a plot of the coefficient of condensation as a function of the target temperature shows a minimum at −95° C, because some of the mercury atoms,which strike mercury crystals already formed on the cooled target, evaporate again before they can find a growth centre. R.Schnurmann

536.423.1 : 532.612.4

8730. THE ENERGIES OF VAPORIZATION AND ACTIVATION FOR FLOW AND THE TEMPERATURE DEPENDENCE OF SURFACE TENSION. S.S.Mitra and N.K.Sanyal.
Z. phys Chem. (Leipzig), Vol. 208, No. 5-6, 257-64 (April, 1958).

Based on the consideration of free volume in a liquid it is shown that the energy of vaporization and the free energy of activation for flow are simple functions of temperature, and justification thereby afforded for Antoine's vapour pressure equation and for the empirical temperature–viscosity relation of Tamman and Hesse. From the relationship between the surface tension S and viscosity of liquids, the expression $\log S = A - B/(T_C - T)$ is deduced for the temperature dependence of surface tension in liquids; this is found to be applicable to non- as well as to associated liquids

H.H.Hodgson

536.423.4 : 532.529.7

CONDENSATION INTERFACES IN TWO-PHASE FLOWS. See Abstr. 8610

536.424.1

8731. THE $\alpha \rightleftharpoons \beta$ TRANSITION IN ZIRCONIUM OBSERVED BY MEANS OF THE ELECTRON PROJECTOR.
A.P.Komar and V.N.Shrednik.
Fiz. Metallov i Metallovedenie, Vol. 5, No. 3, 452-64 (1957). In Russian.

The $\alpha \rightleftharpoons \beta$ transition was directly observed on ~ 1 μ crystals of Zr by means of an emission (Müller) microscope working at 10^6 magnification. A detailed series of photographs of the images is reproduced. Both the hexagonal (α) Zr and cubic (β) Zr relative orientations agree with X-ray data. The fact that during the transition there occurs only one of the possible orientations of the new phase is explained, if the transition occurs in a manner requiring minimum change of surface energy. The transition temperature increases sharply with increasing O and N content. Spiral dissolution of α-Zr is observed with reversed electric field. This is believed to be related to the presence of screw dislocations with axes parallel to the normals to $(11\bar{2}0)$,$(10\bar{1}2)$, $(10\bar{1}2)$ and $(2\bar{1}\bar{1}0)$ faces. A.F.Brown

536.424.1 : 539.893

8732. PHASE DIAGRAM OF BISMUTH TO 130 000 kg/cm², 500° C.
F.P.Bundy.
Phys. Rev., Vol. 110, No. 2, 314-18 (April 15, 1958).

The phase diagram of Bi was determined experimentally to 130 000 kg/cm² and 500° C. The observations of Bridgman, and others, to 30 000 kg/cm² and 270° C were generally verified. The new work indicates two new phases of solid Bi and several new triple points. The Bi VI → VIII transition at room temperature and about 125 000 kg/cm² involves a sharp decrease in electrical resistance which can serve as a pressure calibration point in future work. A.

536.462

8733. NUMERICAL CALCULATION OF THE TEMPERATURE RISE IN IGNITION BY HOT WIRES. H.L.Selberg and C.H.Johansson.
Ark. Fys., Vol. 13, Paper 33, 423-7 (1958).

Results are shown graphically of a numerical calculation using a computer of the temperature development in the explosive medium around a wire, the temperature of which is suddenly raised by applying a certain amount of energy. When the explosive heat is released, the explosive medium is assumed to decompose in accordance with the Arrhenius law. S.Weintroub

536.48 : 537.311.31

"SIZE EFFECT" IN ELECTRICAL RESISTIVITY MEASUREMENTS ON SINGLE CRYSTALS OF HIGH PURITY TIN AT LIQUID HELIUM TEMPERATURES. See Abstr. 7901

536.48

8734. THE KINEMATIC VISCOSITY OF LIQUID HELIUM II.
A.D.B.Woods and A.C.H.Hallett.
Canad. J. Phys., Vol. 36, No. 8, 1125-6 (Aug., 1958).

Measurements were made by observing the torsional oscillations of the inner cylinder of a rotating-cylinder viscometer, after the rotation of the outer cylinder had been either started or stopped. At 2.16° K the ratio of dynamic to kinematic viscosity gave a density equal to the total density; at lower temperatures the results were more complex, and indicated a low effective density at low Reynolds numbers. R.G.Chambers

536.483 : 539.17

8735. CRYOSTAT FOR REACTOR IRRADIATION.
C.C.Sartain and H.P.Yockey.
Rev. sci. Instrum., Vol. 29, No. 2, 118-21 (Feb., 1958).

A cryostat for continuously bathing samples in liquid nitrogen or other heat transfer liquids during nuclear reactor irradiation was constructed and successfully operated. The samples to be irradiated at low temperature are immersed in the heat transfer fluid which is high-purity liquefied nitrogen circulating in a closed system at a pressure greater than that of the atmosphere. The liquid is kept below its boiling point throughout its cycle by use of a heat exchanger located outside the reactor shield. The heat exchanger is cooled by commerical liquid nitrogen boiling at atmospheric pressure. Since oxygen and water vapour from the air cannot enter the closed pressurized system, no chemical explosions inside the nuclear reactor have occurred. Baths at other temperatures may be obtained by substituting suitable liquids for the high-purity nitrogen heat transfer fluid and by keeping the heat exchanger at the desired temperature. A.

536.521

8736. PHOTOGRAPHIC TECHNIQUE FOR MEASURING TEMPERATURES IN LUMINOUS ROCKET EXHAUST FLAMES.
F.S.Simmons and A.G.DeBell.
J. Opt. Soc. Amer., Vol. 48, No. 10, 717-21 (Oct., 1958).

The theory of the two path-length method for optically determining flame temperature is reviewed, and the requirements for quantitative photographic measurement are presented. Apparatus which includes a camera with the necessary combination of film and filters to accept light in a narrow wavelength interval, and several adjustable lamps to serve as standard sources, is described. The film record contains an image of the rocket exhaust jet adjacent to the images of the lamp filaments whose temperatures are known from a previous calibration with an optical pyrometer. Comparison of measured intensities with and without a reflector behind the flame yields the emittance and flame temperature. Some results of measurements at the exit regions of rocket nozzles affording nearly optimum expansion are presented. The utility of the method in rocket performance studies is discussed. A.

536.531

8737. THE DEVIATIONS FROM MATTHIESSEN'S RULE FOR PLATINUM RESISTANCE THERMOMETERS IN THE TEMPERATURE RANGE FROM 20 TO 90° K. H.Schultz.
Z. angew. Phys., Vol. 9, No. 9, 465-7 (Sept., 1957). In German.

A new theoretical and experimental investigation shows that the deviations from Matthiessen's rule can be explained theoretically and mathematically formulated. The agreement between the experimental and calculated values of the deviations is good. An analysis of the older measurements of Hodge and Brickwedde (Abstr. 2135/1939), on the behaviour of several platinum resistance thermometers in the temperature range from 10 to 95° K, shows that their results are in accordance with the theory. H.C.Cole

536.55

8738. TEMPERATURE DETERMINATION IN FLAMES BY X-RAY ABSORPTION USING A RADIOACTIVE SOURCE. G.J.Mullaney.
Rev. sci. Instrum., Vol. 29, No. 2, 87-91 (Feb., 1958).

A radioactive source Fe^{55} was used to measure the density of high-temperature combustion products through a flame zone 6.5 cm long. Premixed propane–oxygen and argon were used for the experiments with a porous metal burner. Temperatures were determined downstream of the main reaction zone in the flame of one atmosphere. Temperature profiles were obtained through the preheat and main reaction zone using radioactive Fe^{55} coated on a small platinum wire as a line source. A.

536.631 : 537.312.62

HEAT CAPACITY OF NORMAL AND SUPERCONDUCTING NIOBIUM AND TANTALUM. See Abstr. 8787-8

536.631 : 538.113

EFFECT OF EXCHANGE INTERACTION ON THE THERMAL PROPERTIES OF COPPER SALTS AND COPPER COORDINATION COMPOUNDS. See Abstr. 8860

536.654 : 537.533.2

ATOMIC HEATS OF SUBLIMATION OF METALS. See Abstr. 8810

536.654 : 537.564

LATENT HEAT OF SUBLIMATION OF CARBON. See Abstr. 8835

536.655

8739. MOLECULAR STRUCTURE AND THE HEAT OF VAPORIZATION OF LIQUIDS. I. S.D.Ravikovȳch. Ukrayin. fiz. Zh., Vol. 2, No. 2, 191-5 (1957). In Ukrainian.

Attention is drawn to certain regularities in the heats of vaporization of binary mixtures of methyl, ethyl, propyl, and butyl alcohols and for the pure liquids. It is shown that with equality of free volume for the different liquids there is coincidence of the curves of temperature variation of heat of vaporization. The equation of this curve is derived and some critical temperatures calculated. These tend to exceed experimental values by 1.5 to 2%. C.R.S.Manders

THERMODYNAMICS

536.7

8740. THERMODYNAMICS OF NONSTOICHIOMETRIC NICKEL TELLURIDES. I. HEAT CAPACITY AND THERMODYNAMIC FUNCTIONS OF THE δ PHASE FROM 5 TO 350°K. E.F.Westrum, Jr, C.Chou, R.E.Machol and F.Grønvold. J. chem. Phys., Vol. 28, No. 3, 497-503 (March, 1958).

Heat capacities of the nickel tellurides were measured at compositions $NiTe_{1.1}$ and $NiTe_{2.0}$ (near limits of homegeneity of the δ phase) and at one intermediate composition, $NiTe_{1.5}$, from 5 to 350°K. Heat capacity values and entropy and enthalpy increments are tabulated. No evidence of order–disorder transitions, or thermal anomalies, or of contributions to the thermal properties from the anisotropy or phonon scattering by the holes in the structure on approaching the composition $NiTe_2$ was observed. Although simple additivity of the heat capacities of the constituent elements failed to represent that of the solution compositions adequately, a Kopp–Neumann treatment in terms of the limiting compositions of the δ phase gives good agreement with the experimental heat capacity and entropy of $NiTe_{1.5}$ and hence is useful in interpolating to other intermediate compositions. A.

536.7 : 530.102

AN EXTREME PROPERTY OF THE FREE ENERGY. See Abstr. 8601

ELECTRICITY

ELECTROSTATICS. DIELECTRICS

537.212.08 : 621.387.42

8741. POINT-COUNTER FOR THE INVESTIGATION OF EXTERNAL ELECTROSTATIC FIELDS. B.Sujak. Z. angew. Phys., Vol. 9, No. 8, 404-7 (Aug., 1957). In German.

Describes an experimental investigation of the effect of external fields on the counting rate of a point Geiger-counter. Results are given to show how this effect may be used to determine the distribution of surface charge, for example, on an insulator which is strained or to which a voltage is applied. J.Dutton

537.223 : 621.319.331

8742. PERFORMANCE OF THE CORONA BLADES IN BECKER'S SELF-EXCITING ELECTROSTATIC GENERATOR. K.S.Subudhi. J. sci. Res. Banaras Hindu Univ., Vol. 8, No. 1, 11-18 (Dec., 1957).

Tests, to assess how the performance of the generator is influenced by the positions of the various blades, are described. A.E.Kay

537.226.1

8743. USE OF COMPLEX CONDUCTIVITY IN THE REPRESENTATION OF DIELECTRIC PHENOMENA. F.A.Grant. J. appl. Phys., Vol. 29, No. 1, 76-80 (Jan., 1958).

When the d.c. conductivity of the material is not negligible, the low-frequency part of the Cole–Cole plot (Abstr. 1344/1941) loses its distinctive shape. A complementary representation in terms of complex conductivity is proposed, in which a simple Debye mechanism again results in a semicircle. However, a non-zero value of d.c. conductivity does not cause this representation to lose its distinctive shape in the low-frequency range. Examples of the utility of this representation are given. A.

537.226.1

8744. ON THE MOLECULAR THEORY OF DIELECTRIC POLARIZATION. W.F.Brown, Jr. Physica, Vol. 24, No. 8, 695-6 (Aug., 1958).

The author replies to criticisms by Mandel and Mazur (Abstr. 3060/1958) concerning theoretical expressions from his article in the Encyclopedia of Physics, Vol. 17, 1. Berlin: Springer-Verlag (1956). R.Stratton

537.226.2 : 539.19

8745. ANALYSIS OF DIELECTRIC LOSS IN TWO UREA ADDITION COMPOUNDS: THE HINDERED SINGLE AXIS POLAR ROTATOR. J.I.Lauritzen, Jr. J. chem. Phys., Vol. 28, No. 1, 118-31 (Jan., 1958).

The dielectric behaviour of two real substances is related to their molecular structure by the application of a theory of the general type proposed by Hoffman. The two real substances are the urea addition compounds of 12-bromotricosane and 16-hentriacontanone, where the polar long-chain molecules exhibit dielectric loss through rotation about their long molecular axes between orientational sites. This dielectric loss has been measured by Meakins, who proposed a qualitative theory similar to the one used here. Smith has determined the crystal structure of the urea addition lattice. The orientational sites of the polar molecules are determined by the potential energy of the crystalline field, which is estimated from the geometrical configuration of the lattice by a Lennard-Jones (6-12) potential. The dielectric loss is calculated in terms of the energy minima and maxima of the potential energy. The energy minima and the differences between the energy maxima are evaluated by a fit of the experimental dielectric loss of 12-bromotricosane in urea. These values are in good agreement with the potential energy obtained from the crystal structure. The temperature dependence of the dielectric properties of 12-bromotricosane in urea are predicted under certain assumptions. The validity of these assumptions and the applicability of the theory are investigated by considering the dielectric loss of 16-hentriacontanone in urea over a wide temperature range. A.

537.226.2

8746. INVESTIGATION OF FERROELECTRICS BY TEMPERATURE MEASUREMENT. A.Pilawski. Bull. Acad. Polon. Sci. Sér. Sci. math. astron. phys., Vol. 6, No. 1, 61-5 (1958).

The power loss of a barium titanate ceramic sample subject to a 50 c/s field of 2650 V/cm was investigated by measuring the temperature rise ΔT produced in the sample. The variation of ΔT with temperature shows a peak of 15 deg C at about 110°C followed by a minimum of 5 deg C at the Curie point at 120°C. The peak is suppressed when a large static bias field is applied. Increasing bias field produces a fall in ΔT at low temperatures and an almost linear increase at high temperatures, probably due to an increase in conductivity. At temperatures near 100°C, ΔT has a minimum value for a particular bias field. R.C.Kell

537.226.2

8747. FERROELECTRIC POLARIZATION REVERSAL IN ROCHELLE SALT. H.H.Wieder. Phys. Rev., Vol. 110, No. 1, 29-36 (April 1, 1958).

An experimental investigation of the polarization reversal process in Rochelle salt shows that besides the slow, lateral motion of b- and c-domain walls, there is also a fast reversal process characteristic of the nucleation and wall propagation in the orthorhombic a-direction. Reversal in this direction is qualitatively analogous to the polarization process in c-domain $BaTiO_3$. A.

537.226.2

8748. THE DEPENDENCE OF THE COERCIVE FIELD OF TRI-GLYCINE SULPHATE ON TEMPERATURE AND FREQUENCY. S.Domanski. Proc. Phys. Soc., Vol. 72, Pt 2, 306-7 (Aug., 1958).

The hysteresis loops of tri-glycine sulphate crystals are rectangular and symmetrical. Curves are given showing that the coercive field begins to increase rapidly below −30°C, and that it increases with frequency over the range 30-3000 c/s. R.C.Kell

537.226.2

8749. ULTRA-LOW-VELOCITY COMPONENT OF SPONTANEOUS POLARIZATION IN $BaTiO_3$ SINGLE CRYSTAL. K.Husimi. J. appl. Phys., Vol. 29, No. 9, 1379-80 (Sept., 1958).

Absolute measurement of the polarization, using the piezoelectric output produced by ultrasonic mechanical excitation, shows that the spontaneous polarization is 44 $\mu C/cm^2$ and consists of two parts:

a high-velocity component of 26 $\mu C/cm^2$ and an ultra-low-velocity component of 18 $\mu C/cm^2$, which takes more than 20 days to reverse completely when a field of 10 kV/cm is applied. The result is confirmed by measuring the charge released when fully polarized samples are dipped into hot silicone oil. Triglycine sulphate does not have a low-velocity component of polarization. R.C.Kell

537.226.2

8750. BARKHAUSEN PULSES IN BARIUM TITANATE. A.G.Chynoweth.
Phys. Rev., Vol. 110, No. 6, 1316-32 (June 15, 1958).

A study was made of the Barkhausen pulses that occur during polarization reversal in single crystals of barium titanate. By both pulse counting and oscillographic techniques, the pulse shapes and in particular their heights and rise times were studied as a function of the crystal thickness and the applied field strength. The pulse shape represents an initial rapid increase in the volume of the region switched followed by a slower relaxational type of growth, the latter being described by a time constant of 5 to 6 μsec. The pulse heights increase with the crystal thickness and linearly with the applied field while they are practically independent of temperature between room temperature and 94°C. The relaxation time is essentially independent of the crystal thickness, of the applied field, and of the pulse height. The total number of pulses in a given crystal is independent of the field and temperature. In crystals 5×10^{-3} cm thick, the average volume corresponding to a pulse is 10^{-11} cm^3 while the total volume represented by all the pulses is less than one percent of the crystal volume between the electrodes. Individual pulses occur quite independently of each other and of their surroundings. These observations are not consistent with the usual jerky domain-wall motion models for the generation of Barkhausen pulses. It is concluded that the eventual size and shape of the rapidly switching region represented by a Barkhausen pulse are mainly determined by the crystal thickness and the condition that the depolarizing field within the region must not exceed the applied field. This criterion is successful in accounting for some of the features of the pulses if the region is assumed to be spike-shaped and extending more or less through the crystal thickness, in particular, the average pulse size and its dependence on the field. These deductions suggest that the Barkhausen pulses could represent the nucleation and initial stages of growth of new spike-shaped domains extending along the c-axis and that the fixed number of pulses given by a crystal would then indicate a definite number of nucleating sites on the crystal surfaces. Under certain conditions a spike-shaped critical nucleus is consistent with the empirically determined nucleation probability factor, $\exp(-\alpha/E)$, where E is the applied field strength. To account for the polarization reversal in the remainder of the crystal it is presumed that, after their formation, the spikes expand radially (sideways) in all directions. By using this model the rate of polarization reversal as a function of time can be formulated, assuming that the radial wall velocity is proportional to the field and the nucleations occur randomly. Satisfactory agreement with experiment is obtained at low fields if it is assumed that the expanding domains stop short of overrunning adjacent nucleating sites. Relaxing this restriction for higher fields again leads to good agreement with experiment. Also, the observed dependence of the switching time and the maximum current on the applied field is predicted by using certain approximations. A.

537.226.31

8751. DIELECTRIC LOSSES AND ADDED COLORATION OF CALCIUM FLUORIDE. G.Jacobs.
J. Chim. phys., Vol. 55, No. 6, 472-4 (June, 1958). In French.

Crystals were thermally treated at fixed temperatures in the range from 600° to 900°C in air and then the tan δ v. frequency curves were measured at temperatures from about 90° to 200°C. For heat treatments up to 800°C a dielectric relaxation effect was introduced, presumably by the oxygen taken up during the heat treatment, but this was not observed for treatments at 860°C. The effect may have been swamped by the large conductivity increase achieved by this heat treatment. Results on coloured CaF_2 are also reported. C.A.Hogarth

537.226.8

8752. ON DIELECTRIC SATURATION IN PURE POLAR LIQUIDS AND THEIR SOLUTIONS. A.Chelkowski.
J. chem. Phys., Vol. 28, No. 6, 1249-50 (June, 1958).

537.226.8

8753. DIELECTRIC BREAKDOWN OF KCl CRYSTALS IRRADIATED WITH γ-RAYS. Y.Inuishi and T.Suita.
Phys. Rev., Vol. 109, No. 5, 1509 (March 1, 1958).

Irradiation with γ-rays causes marked changes in the d.c. dielectric strength of KCl crystals both with and without illumination with visible light, whereas the impulse dielectric strength is not significantly changed. The results are ascribed to space charge and electron trapping. A.

537.228 : 621.372.412

8754. HIGH Q QUARTZ CRYSTALS AT LOW TEMPERATURES. D.L.White.
J. appl. Phys., Vol. 29, No. 5, 856-7 (May, 1958).

The Q of natural quartz was measured from 4.2°K to over 100°K. The quartz was in a high precision AT crystal unit vibrating on overtones of the thickness shear at about 6.3 Mc/s and 8.8 Mc/s. At higher temperatures Q varied rapidly with temperature, but did not depend on the particular mode of vibration. At low temperatures (< 10°K) Q also depended on the mode of vibration. At these low temperatures Q became very large — 55×10^6 was observed on one mode at 4.2°K. Apparently another loss mechanism dominates at low temperatures, and very likely this mechanism may not be intrinsic to quartz. The mounting structure or gold electrodes may be the primary source of energy loss in the liquid helium temperature range. A.

537.228 : 534.23

INFLUENCE OF ELECTROSTATIC FIELD ON THE ABSORPTION OF SOUND IN ROCHELLE SALT. See Abstr. 8651

537.228.1 : 539.32

8755. ELASTIC AND PIEZOELECTRIC CONSTANTS OF ALPHA-QUARTZ. R.Bechmann.
Phys. Rev., Vol. 110, No. 5, 1060-1 (June 1, 1958).

The elastic and piezoelectric constants of alpha-quartz were determined by the resonance (previously known as dynamic) method employing the extensional mode of bars and the contour-extensional mode I (Lamé mode) of square plates. It is believed that this approach results in very accurate values. A.

ELECTRIC CONDUCTION. CURRENTS

537.311.3 : 538.63

8756. GALVANOMAGNETIC COEFFICIENTS FOR ARBITRARY GEOMETRY. R.M.Broudy.
J. appl. Phys., Vol. 29, No. 5, 853-5 (May, 1958).

An analogue technique is described by which it is possible to obtain, without analytical computation, the Hall coefficient and magnetoresistance for any two-dimensional sample with the magnetic field perpendicular to the plane of the sample, without regard for sample shape or electrode size and configuration. A.

537.311.31 : 539.219

8757. THE INFLUENCE OF SHORT-RANGE ORDER ON THE ELECTRICAL RESISTIVITY OF ORDERING ALLOYS. A.F.Polesya and B.N.Finkel'shtein.
Fiz. Metallov i Metallovedenie, Vol. 5, No. 3, 554-6 (1957). In Russian.

When short-range order is taken into account, a complex formula is found for the variation of electrical resistivity (ρ) near the Curie temperature. The new formula gives values for the temperature variation of ρ, differing by 2-3% from experiment. With a formula taking account only of long-range order the corresponding discrepancy is 10-12%. A.F.Brown

537.311.31

8758. NATURE OF ELECTRICAL RESISTIVITY OF THE FERROMAGNETIC METALS AT LOW TEMPERATURES. E.Kondorsky, O.S.Galkina and L.A.Tchernikova.
J. appl. Phys., Vol. 29, No. 3, 243-6 (March, 1958).

The study of the resistivity of nickel, iron, and nickel—copper alloys with copper concentration up to 25%, at temperatures from 2°K to 78°K, was carried out. The empirical formulae for resistivity in this temperature range were found. It was shown that the "phonon" term in T^5 does not play an essential role in the resistance of ferromagnetic metals at temperatures up to 20-30°K, but that it contributes to the resistance above these temperatures. The values of $(\rho-\rho_0)/n$ for nickel and iron (where ρ and ρ_0 are the resistivity and residual resistivity at 0°K, respectively, $n = (T/\theta)^{3/2}$ is the "magnon" concentration, θ is the exchange parameter in Bloch's $\frac{3}{2}$ law), and the value of $\Delta\rho/\Delta n$ for nickel (where $\Delta\rho$ is the change of resistivity, $\Delta n = \Delta I_s/I_0$ the decrease of magnon concentration, and ΔI_s the increase of true magnetization in strong magnetic field) were found and compared with each other. It was shown that

both of these values for nickel are of the same order and also the same order as the value of $\Delta\rho_0/\nu$, where $\Delta\rho_0$ is the increase of residual resistivity of nickel copper alloys with the concentration ν of copper in these alloys. The coincidence of the above-mentioned values is considered to be an indirect proof for the assumption that the temperature dependent part of the resistance of ferromagnetic metals at low temperatures is related to the scattering of electrons by magnon. A.

537.311.31 : 539.2

RESISTIVITY OF INTERSTITIALS IN COPPER. See Abstr. 8440

537.311.33 : 536.7

8759. IRREVERSIBLE THERMODYNAMICS AND CARRIER DENSITY FLUCTUATIONS IN SEMICONDUCTORS. K.M.van Vliet.
Phys. Rev., Vol. 110, No. 1, 50-61 (April 1, 1958).

The formalism of irreversible thermodynamics is applied to the kinetics of carrier transitions in semiconductors. The thermodynamic forces, the generalized resistances and admittance functions are introduced. It is shown that the thermodynamic forces which establish the regression of a perturbed state to equilibrium are the differences of the quasi-Fermi levels that have to be assigned to each group of carriers; the generalized resistances are simply related to the transition rates. It is then possible to write the kinetic equations for the rate of change of the various carrier concentrations in a unified form so that the dissipation–fluctuation theorem of Callen and Greene (Abstr. 5750/1952, 1595/1953) can be applied. The spectral density matrix of the spontaneous carrier fluctuations is immediately found from the admittance matrix. The results can be expressed in a closed form which is valid for nondegenerate as well as for degenerate semiconductors. An electrical network analogue is also outlined. The theory is applied explicitly to electronic noise in extrinsic and near-intrinsic crystals with and without recombination centres. Finally, the close connection with statistical results obtained before is discussed and the complete agreement between the Einstein relation and the extended "g–r theorem" for the variances is established. A.

537.311.33

8760. MEASUREMENT OF MINORITY CARRIER LIFETIMES WITH THE SURFACE PHOTOVOLTAGE. E.O.Johnson.
J. appl. Phys., Vol. 28, No. 11, 1349-53 (Nov., 1957).

The surface photovoltage method uses the junction-like properties of a semiconductor surface as a means for studying the decay of excess carriers. No more than capacitive contact with the specimen is required to detect the surface photovoltage which, in the millivolt range, is a linear function of the excess carrier density. Theoretically, the surface method yields exactly the same carrier decay constant as the photoconductivity method when the lowest diffusion mode prevails in the specimen. This was quantitatively confirmed for Ge: only qualitative confirmation was made with Si. For surfaces tending toward inversion, the surface method gives larger signals than the photoconductivity method, particularly for semiconductors with low intrinsic carrier density. On the other hand, for accumulation layer surfaces the surface method usually gives smaller output signals. A.

537.311.33 : 539.2

THE EFFECT OF STATIC INHOMOGENEITIES OF THE CRYSTALLINE LATTICE ON THE ELECTRONIC PROPERTIES OF A SEMICONDUCTOR. See Abstr. 8442

537.311.33 : 538.61

8761. OSCILLATORY MAGNETO-ABSORPTION IN SEMICONDUCTORS. S.Zwerdling, B.Lax and L.M.Roth.
Phys. Rev., Vol. 108, No. 6, 1402-8 (Dec. 15, 1957).

Infrared magneto-absorption was investigated in thin samples ($\sim 10\,\mu$) of germanium, indium arsenide, and indium antimonide in magnetic fields up to 37 kG. At photon energies greater than the direct transition energy gap in germanium and also greater than the energy gaps in indium arsenide and indium antimonide, the magneto-absorption exhibited oscillatory behaviour. This is associated with interband transitions between quantized Landau levels of the valence and conduction bands. By extrapolating a plot of the photon energies of the transmission minima as a function of magnetic field to zero field, accurate determinations of the energy gaps were obtained. For the direct transition in germanium, $E_0 = 0.803 \pm 0.001$ eV at $\sim 298^\circ$K, 0.890 ± 0.001 eV at $\sim 77^\circ$K, and 0.897 ± 0.001 eV at $\sim 4^\circ$K. In indium antimonide, $E_g = 0.180 \pm 0.002$ eV at $\sim 298^\circ$K, amd in indium arsenide, the result was 0.360 ± 0.002 eV at $\sim 298^\circ$K. From the accurate determination of the energy gap made possible by these experiments, it is apparent that there is considerable absorption below the energy gap, probably due to transitions involving both photons and optical phonons. Utilizing the theory of Luttinger and Kohn, effective masses were evaluated from the higher quantum transitions in germanium to give values of the conduction band electron mass at $k = 0$ of $(0.036 \pm 0.002)m_0$ at room temperature, and $(0.043 \pm 0.002)m_0$ and $(0.041 \pm 0.002)m_0$ at $\sim 77^\circ$K and $\sim 4^\circ$K, respectively, which is consistent with the corresponding change in energy gap. For indium arsenide, the conduction band electron mass was found to be approximately $0.03m_0$. For indium antimonide, a value for the effective mass in the conduction band of $\sim 0.014m_0$, consistent with the cyclotron resonance results, was obtained by assuming that in this case the magnetic levels in the conduction band are appreciably split by spin-orbit interaction. The anisotropy of the magneto-absorption effect was measured for germanium and indium antimonide. For germanium, the anisotropy agreed with predictions from theory and the results of microwave cyclotron resonance. For indium antimonide, the anisotropy was very small for the first two minima. A.

537.311.33

8762. HALL AND TRANSVERSE MAGNETORESISTANCE EFFECTS FOR WARPED BANDS AND MIXED SCATTERING. A.C.Beer and R.K.Willardson.
Phys. Rev., Vol. 110, No. 6, 1386-94 (June 15, 1958).

Evaluation of the transport integrals for warped bands using the method of McClure (Abstr. 3718/1956) was done for relaxation times determined by mixed scattering from acoustic phonons and ionized impurities. Hall and transverse magnetoresistance coefficients were calculated for parameters characteristic of the degenerate valence bands in germanium and silicon, as obtained from cyclotron resonance data. For germanium, results are consistent with observation in regard to a density-of-states ratio for fast and slow holes of approximately 4% and in the occurrence of fine structure, especially a minimum in the Hall coefficient between 1000 and 2000 gauss at 80°K, depending on the impurity content. With parameters representative of silicon, substantially different behaviour is predicted, in line with experiment. A.

537.311.33 : 538.63

8763. THE GEOMETRICAL EFFECT ON THE TRANSVERSE MAGNETORESISTANCE OF RECTANGULAR DISKS OF SEMICONDUCTOR. H.J.Lippmann and F.Kuhrt.
Z. Naturforsch., Vol. 13a, No. 6, 462-74 (June, 1958). In German.

The transverse magnetoresistance is divided into two parts resulting from a mobility change and a change in the path taken for the charge carriers to flow. The effects are analysed using the Hall-angle concept, and exact solutions are obtained for rectangular specimens. C.A.Hogarth

537.311.33 : 538.63

8764. THE GEOMETRICAL EFFECT ON THE HALL EFFECT OF RECTANGULAR DISKS OF SEMICONDUCTOR. H.J.Lippmann and F.Kuhrt.
Z. Naturforsch., Vol. 13a, No. 6, 474-83 (June, 1958). In German.

See preceding abstract. A similar analysis is made to show how the Hall effect depends on the shape and size of the specimen. C.A.Hogarth

537.311.33 : 539.19

A SEMICONDUCTOR DETECTOR FOR SULPHUR AND SELENIUM MOLECULAR BEAMS. See Abstr. 8404

537.311.33 : 621.315.59

8765. PREPARATION AND PROPERTIES OF ALUMINUM ANTIMONIDE. A.Herczog, R.R.Haberecht and A.E.Middleton.
J. Electrochem. Soc., Vol. 105, No. 9, 533-40 (Sept., 1958).

The high-energy gap intermetallic compound semiconductors, AlSb, GaAs, and InP, are considered as potential materials for devices operating at temperatures in excess of the limit for silicon. A comparative evaluation of these semiconductors is given which reveals some of the advantages and disadvantages of AlSb. Aluminium and antimony of high purity were prepared by zone refining, and single crystals of AlSb were grown by the Czochralski technique. Effects of various impurities in the starting materials and crucibles on the electrical properties are discussed, and equipment for crystal growing under equilibrium vapour pressure of Sb is described. The resistivity of as-grown p-type crystals can be decreased substantially by doping with carbon and increased by small quantities of Se and Te. A larger quantity of Te will change the crystals to n-type. P–n junctions were made by controlled doping during crystal growing. Effects of various surface treatments on the electrical

properties of AlSb are discussed, and some data on point contact and p–n junction diodes are presented. A.

537.311.33 : 621.315.59

8766. EXPERIMENT SHOWING THE INFLUENCE OF SURFACES ON 1/f NOISE IN GERMANIUM. J.J.Brophy.
J. appl. Phys., Vol. 29, No. 9, 1377-8 (Sept., 1958).

A cross-shaped specimen had grooves cut centrally on it parallel to one arm of the cross; the effective surface to volume ratio was thus higher for current passing parallel to the grooves than for that perpendicular to them, and the relative contributions of surface and volume noise could be deduced. The results showed that etched surfaces were 40 times as noisy as sandblasted ones.

C.Hilsum

537.311.33

8767. GENERATION RECOMBINATION NOISE IN INTRINSIC AND NEAR-INTRINSIC GERMANIUM CRYSTALS.
J.E.Hill and K.M.van Vliet.
J. appl. Phys., Vol. 29, No. 2, 177-82 (Feb., 1958).

Measurements are reported on noise in germanium single crystals at temperatures between 300°K and 450°K. In this range the crystals were near-intrinsic or intrinsic. The 1/f noise component was negligible in all cases above 1 kc/s provided the noise was measured between probes. The noise above thermal noise measured in this way could entirely be attributed to spontaneous fluctuations in generation and recombination of carriers. From the spectra lifetimes varying from 2 μsec for poorly etched crystals up to 100 μsec for the best etched crystals were found. The results are compared with the theory considering generation and recombination by means of direct transitions or via recombination centres located either in the bulk or at the surface. Very reasonable agreement is found in most cases. In some cases the spectrum falls off rather weakly at higher frequencies which indicates that the recombination centres do not lie at a single sharp energy in the forbidden gap but are distributed within a small range. A.

537.311.33

8768. THE INFLUENCE OF ANNEALING ON LOCAL LEVELS AND THE LIFETIME OF NON-EQUILIBRIUM CURRENT CARRIERS IN P-TYPE GERMANIUM WITH ADDED IRON.
K.D.Glinchuk, E.G.Miselyuk and N.N.Fortunatova.
Zh. tekh. Fiz., Vol. 28, No. 5, 1053 (1958). In Russian.

A specimen of Ge containing 3×10^{14} Fe atoms/cm^3 was annealed at 470°C for 24 hr. Before annealing the resistivity, ρ, and lifetime, τ, were 46.8 ohm cm. (p-type) and 0.5 μsec, and after annealing they were 30.6 ohm cm (n-type) and 40 μsec (room temperature values). Hall constant measurements (125-400°K) showed that an Fe^- level at 0.34 ± 0.02 eV from the valence band edge which was present before annealing was absent afterwards. The change from p-type to n-type is thus explained, and τ is increased because the level when present acts as a recombination centre (capture cross-section for electrons $\sim 10^{-15}$ cm^2). Observations on other p-type specimens containing Fe (not annealed) gave τ as typically 1-20 μsec for ρ 1-50 ohm cm; the smallest value of τ observed being 0.15 μsec for 4 ohm cm Ge.

K.F.Hulme

537.311.33 : 539.27

SURFACE STUDIES ON SINGLE-CRYSTAL GERMANIUM. See Abstr. 9148

537.311.33 : 538.63

8769. MAGNETORESISTANCE OSCILLATIONS IN SINGLE-CRYSTAL AND POLYCRYSTALLINE INDIUM ARSENIDE.
R.J.Sladek.
Phys. Rev., Vol. 110, No. 4, 817-26 (May 15, 1958).

Measurements of the electrical resistivity of single-crystal and polycrystalline samples of n-type InAs were made as a function of magnetic field strength up to 29 000 G at temperatures between 1.25° and 20.2°K. In both samples oscillations in the resistivity are observed as the magnetic field strength is varied, both when the field is parallel to and when it is perpendicular to the current direction. The oscillations are damped periodic functions of reciprocal field strength. For each sample the period observed in longitudinal and in transverse fields is the same and agrees with that calculated from the electron concentration obtained from the Hall coefficient. The observed phases, at least in the single-crystal sample, agree fairly well with that predicted by theory which is based on a quasi-free electron model. An exponential field dependence of the amplitude of the oscillations is found, indicating the presence of energy-level broadening that can be characterized by a collision-broadening time which is related to the scattering relaxation time obtained from the mobility in a manner consistent with theory. Collision broadening also accounts for the similarity of oscillations observed in transverse and in longitudinal fields and for the absence of higher harmonics in the magnetoresistance oscillations. The temperature dependence of the amplitude of the oscillations has been studied in a range of $kT/h\omega$ not usually obtained. The results for the temperature dependence can be fitted by the theoretically determined form, $x/\sinh x$, where $x = 2\pi^2 kT/h\omega$, and thereby allow a value for the effective mass of conduction electrons to be determined. A.

537.311.33 : 535.39 : 535.23

INFRARED EMISSIVITIES OF InSb AND Ge. See Abstr. 8669

537.311.33 : 539.374

MOTION OF POSITIVE HOLES IN $Li_xMn_{1-x}O$. See Abstr. 9154

537.311.33 : 539.21

8770. POST-BOMBARDMENT CONDUCTIVITY IN MgO CRYSTALS. R.A.Shatas, J.F.Marshall and M.A.Pomerantz.
Phys. Rev., Vol. 109, No. 6, 1953-8 (March 15, 1958).

Electrical conductivity following the termination of bombardment by 1.3 MeV electrons was observed in MgO crystals. Depending upon the rate of decay, one of two different techniques is utilized to determine the time-constants at various temperatures. Short time-constants at high temperatures are measured oscillographically, whereas long time-constants at low temperatures are determined by a d.c. method. In the former case, a single exponential function fits the crystal current v. time data, whereas in the latter, a departure occurs. This is accounted for by the theoretical analysis which provides a procedure for determining the relevant time-constant. The post-bombardment time-constant, τ, changes with temperature in accordance with the relationship $\tau = \tau_0 \exp(E/kT)$, where τ_0 is essentially constant, and E = 1.4 eV. The experimental results are interpreted in terms of a theoretical model involving shallow and deep traps. Thermal re-emission of charge carriers from the former former, constituting a single level, occurs following bombardment. A second level in addition to that at 1.4 eV was determined at 0.7 eV by an extension of the technique. The former very likely corresponds to the 2.1 eV optical transition observed previously, in which case the charge carriers involved in this thermal process are holes. A.

537.311.33 : 535.345

INTRINSIC OPTICAL ABSORPTION AND THE RADIATIVE RECOMBINATION LIFETIME IN PbS. See Abstr. 8698

537.311.33

8771. EFFECT OF HEAT TREATMENT UPON THE ELECTRICAL PROPERTIES OF SILICON CRYSTALS. C.S.Fuller and R.A.Logan.
J. appl. Phys., Vol. 28, No. 12, 1427-36 (Dec., 1957).

Studies were made of the process in which donors are introduced into silicon by heating in the temperature range 300°-500°C, and are caused to disappear on heating at higher temperature. This phenomenon is shown to depend on the conditions of growth and the heat-treatment history of the crystal. Evidence is summarized which shows that oxygen is the impurity from which the donors are formed. The characteristics of the processes involved are described and possible mechanisms are discussed. A.

537.311.33

8772. IONIZATION RATES FOR ELECTRONS AND HOLES IN SILICON. A.G.Chynoweth.
Phys. Rev., Vol. 109, No. 5, 1537-40 (March 1, 1958).

The ionization rates for holes and electrons in silicon were determined over the following ranges of field: for holes, $(2.5\text{-}6.0) \times 10^5$ V/cm; for electrons, $(2.0\text{-}5.0) \times 10^5$ V/cm. The ionization rate for electrons is higher than that for holes. The results suggest that the field dependence of the ionization rate for holes, and, probably, for electrons also, can be expressed by a $\exp(-b/E)$, where E is the field. The constants a and b are different for electrons and holes. A.

537.311.33

8773. ON THE EFFECT ON Ge POINT TRIODES OF THE LIFETIME OF MINORITY CARRIERS.
K.D.Hlynchuk, H.K.Ivanova and O.H.Miselyuk.
Ukrayin. fiz. Zh., Vol. 2, No. 4, 338-46 (1957). In Ukrainian, with summary (1 p.) in Russian.

The influence is examined of minority carrier effective lifetimes upon the amplification factor and maximum frequency for point triodes made of Ge. The effective lifetime of minority carriers is found to depend upon surface and upon volume combination.

C.R.S.Manders

537.311.33 : 621.382

8774. THE INFLUENCE OF CLOSELY SPACED CONNECTIONS ON THE D.C. AND A.C. BEHAVIOUR OF P–N JUNCTIONS. H.Beneking.
Z. angew. Phys., Vol. 9, No. 12, 626-31 (Dec., 1957). In German.

Gives a theoretical analysis of the minority carrier contributions to the properties of a planar p–n junction between uniform p and n regions of thickness comparable with the diffusion distances and backed by contacts having infinite recombination velocity. Recombination in the depletion layer is neglected. The voltage-dependence of the thickness of the depletion layer, and hence of the p and n regions, leads to an apparent leakage conductance, under reverse bias, which increases rapidly with temperature. Under zero and forward bias the diffusion conductance can be much greater and the diffusion capacitance smaller than for a junction with remote ohmic connections. A numerical example is worked out.

F.F.Roberts

537.311.33 : 621.382

8775. THE D.C. AND A.C. PROPERTIES OF POINT-CONTACT DIODES. H.Beneking.
Z. angew. Phys., Vol. 10, No. 5, 216-25 (May, 1958). In German.

Extends a previous study (see preceding abstract) of the planar p–n junction with spacially-close contacts, and gives a detailed theoretical analysis of a p–n junction of spherical-shell form, taking account of the finite thicknesses of the n- and p-type regions and assuming infinite recombination velocities at both the inner and outer contacts to the electrodes. Expressions are derived for the d.c. and a.c. characteristics, including the marked effects of geometry on injection ratio and on the negative slope conductance that can occur under reverse bias conditions. Several experimental diode characteristics are matched to calculated curves, for which the assumed quantitative parameters are tabulated. F.F.Roberts

537.311.33

8776. SEMICONDUCTOR PROPERTIES OF RECRYSTALLIZED SILICON IN ALUMINUM ALLOY JUNCTION DIODES. R.A.Gudmundsen and J.Maserjian, Jr.
J. appl. Phys., Vol. 28, No. 11, 1308-16 (Nov., 1957).

This is a study of the basic electrical properties of thin recrystallized regions formed in the fabrication of p–n junctions by the alloying of pure aluminium on n-type silicon single crystals. The average aluminium concentration is about 7×10^{18} cm^{-3}, and varies by a factor of 4 to 5,being largest in the region first recrystallized and decreasing in a linear manner to the surface immediately beneath the aluminium–silicon eutectic. The average Hall-hole mobility is about 55 cm^2 V^{-1} sec^{-1} and varies from 35 to 75 cm^{2}V^{-1} sec^{-1} across a region formed by precipitating from 977°C to the eutectic. Across the same region the conductivity varies from 72 to 35 mho cm^{-1}. The built-in field which is both a function of depth and total width can vary from 10 to 200 V/cm in typical cases. The minority carrier (electron) diffusion length ranges from 4 to 12 μ. The temperature dependence of the distribution coefficient corresponds to an enthalpy change (differential heat of solution) of +0.43 eV necessary for the transfer of an atom of aluminium from the liquid to the solid. A.

537.311.33

8777. EFFECTS OF ELECTRODE MATERIALS AND SURFACE PREPARATION ON CdS–METAL CONTACTS. R.A.Greiner, R.F.Miller and R.C.Retherford.
J. appl. Phys., Vol. 28, No. 11, 1358-9 (Nov., 1957).

Experimental studies on the effects of contact materials and crystal surface preparation on the voltage–current characteristics of contacts to CdS single crystals are presented. Rectifying contacts are influenced by the surface preparation prior to electrode application. An artificially roughened or naturally rough crystal surface tends to reduce the rectification ratio of a contact. Two kinds of current fluctuations that may be attributed to the contacts are observed. A.

537.311.33

8778. FIELD MODULATION OF LIQUID INDUCED EXCESS SURFACE CURRENTS ON GERMANIUM P–N JUNCTIONS. W.T.Eriksen.
J. appl. Phys., Vol. 29, No. 4, 730-2 (April, 1958).

The field induced current is shown to conform to the behaviour seen by liquid induced currents on germanium surfaces. The modulation increases with decreasing temperature down to the melting point of the liquid and then decreases radically to nearly zero. The modulation effect is seen only when polar liquid ambients are used. A qualitative explanation of the effect is discussed in terms of a model for current conduction in which the charge carriers move in the liquid outside of the semiconductor. The increased current with external field is thought to arise from the orientation of the dipoles in the liquid giving increased mobility to the charge carriers. A.

537.311.33 : 669.09

PREPARATION OF LARGE-AREA P–N JUNCTIONS IN MONOCRYSTALLINE SILICON BY SURFACE MELTING. See Abstr. 9199

537.312.5

8779. RADIATION DISCRIMINATION WITH PHOTOCONDUCTING CRYSTALS. Y.T.Sihvonen and D.R.Boyd.
J. appl. Phys., Vol. 29, No. 1, 85-8 (Jan., 1958).

A mathematical study was carried out on the properties of an array of photoconducting receivers subjected to an influx of photons. Those photons not absorbed by the first receiver pass on to the second receiver and so on until all the initial photons are absorbed. The capture of a photon is indicated by an increase in receiver conductance. Analysis of the problem reveals that if the receiver thicknesses are permitted to vary in a prescribed way interesting response differences result for photons having different energies. Under certain conditions, these reponse differences can be used to resolve two classes of photons differing in energy into a spectrum. A.

537.312.5

8780. ORGANIC PHOTOCONDUCTORS. IV. SIGN OF THE CHARGE CARRIER. R.C.Nelson.
J. chem. Phys., Vol. 29, No. 2, 388-90 (Aug., 1958).

For Pt III see Abstr. 7441 (1954). If the energies of carriers in the conduction band and valence band of a dye can be determined with respect to the corresponding levels in cadmium sulphide, then the sign and magnitude of the photo-e.m.f. developed at a junction between dye and cadmium sulphide can often be interpreted as indicating a transfer of carriers between conduction bands, conduction hence being due primarily to electrons; or as a transfer between valence bands, conduction thus being due to holes. In this way the majority carrier in several cationic dyes is shown to be electrons; in erythrosin, an anionic dye, holes; and in methyl chlorophyllide-a, a non-ionic dye, probably electrons. A.

537.312.5

8781. DE-EXCITATION OF ZnS AND ZnCdS PHOSPHORS BY ELECTRIC FIELDS. H.Kallmann, B.Kramer and P.Mark.
Phys. Rev., Vol. 109, No. 3, 721-9 (Feb. 1, 1958).

The change of impedance (photoconductivity) of certain ZnS and ZnCdS powder phosphor samples, brought about by external a.c. (60 c/s) and d.c. fields (up to 15 000 V/cm), applied both during and after excitation with ultraviolet light (3660 A), is described and compared with impedance changes due to irradiation with infrared light. Application of a d.c. field simultaneously with the exciting radiation results first in a sudden drop in both the capacitance ($\Delta C/C_0$) and the dissipation factor ($D = 1/Q$) followed by a recovery to a new equilibrium level below the field-free case. Removal of the field is accompanied by another drop and a recovery to the original field-free values. The partial recovery is not seen during a.c. field application under the same conditions but the complete recovery also occurs upon field removal. Applied during the photoconductivity decay, both a.c. and d.c. fields accelerate the decay. The sudden drop and partial recovery under d.c. fields is also seen during the photoconductivity decay but to a lesser extent. These phenomena are explained by a consideration of the distribution of conduction electrons created by the application of the field. The sudden capacitance drop seen under a d.c. field is attributed to a polarization effect. The free charge is swept close to the electrodes leaving the bulk of the phosphor sample non-conducting. The partial recovery is due to the buildup of the back field as well as to an increase in the conductivity of the bulk of the phosphor grains due to the creation of additional free charge by the exciting radiation and the emptying of traps into the conduction band. There is no partial recovery during a.c. field application because of the absence of the polarization field. The finite recovery time after field removal when the phosphor is under excitation as well as the acceleration of the photoconductivity decay due to the field application is attributed to a quenching action brought on by an increase in the recombination rate in those regions of the phosphor powder sample where conduction electrons have been piled up by the action of the applied field. A.

537.312.5

8782. ELECTRIC FIELD DISTRIBUTION IN POLARIZED PHOTOCONDUCTORS. H.Kallmann and J.R.Freeman.
Phys. Rev., Vol. 109, No. 5, 1506-8 (March 1, 1958).

Persistent internal polarization is shown to result from the accumulation of trapped charge near the surface layers of a photoconductor. At equilibrium it is predominantly of a bulk nature, rather than being localized in individual grains. The charge layers are found to be restricted to narrow regions from 5 to 10 microns from each surface. This distance is almost independent of sample thickness and polarizing voltage. While the external field is still applied, the equilibrium state of polarization is such that between the layers the field approaches zero. This is concluded from the fact that the buildup and release of polarization proceed at the same rate when equal exciting intensities are used. A.

537.312.5

8783. ON HALL'S FORMULA FOR THE RELATIVISTIC PHOTOEFFECT. M.Gavrila.
Nuovo Cimento, Vol. 9, No. 2, 327-30 (July 16, 1958).

A certain approximation to the relativistic K-shell photoeffect cross-section is criticized. The correct expression is found to first order in αZ. R.J.N.Phillips

537.312.5 : 535.345

PHOTOEMISSION OF BARIUM AND STRONTIUM OXIDES, SULFIDES, SELENIDES, AND TELLURIDES. See Abstr. 8700

537.312.5 : 541.183

PHOTODESORPTION IN ZINC OXIDE SEMICONDUCTOR. See Abstr. 9172

537.312.62 : 538.222

8784. PARAMAGNETIC EFFECT IN SUPERCONDUCTORS. V. RESISTANCE TRANSITION OF TIN WIRES. H.Meissner.
Phys. Rev., Vol. 109, No. 3, 668-80 (Feb. 1, 1958).

For Pt IV see Abstr. 7124 (1957). The resistance of tin wires between 0.15 and 3 mm in diameter was measured as a function of the current in the transition region to superconductivity. The samples used were, with one exception, single crystals and had residual-resistance ratios $r_0 = R_{0\,°K}/R_{273\,°K}$ of a few times 10^{-5}. Most of the transition curves showed a steep rise and a break at the critical current. The critical resistance, defined as the resistance at the break of the curves, is for single crystals independent of the temperature between 1.9° K and the critical temperature, if proper corrections for the temperature dependence and the field dependence of the resistivity are made. Extensive measurements of these dependences have been made for this purpose. Measurements on one polycrystalline sample and comparison with measurements by Rinderer showed a strong influence of the electronic mean free path on the ratio of the critical resistance to the normal resistance, this ratio being smaller for the purer samples with the longer mean free paths. The single crystals which were used here were probably still not quite good enough to represent samples free from all imperfections. The heat transfer from horizontal wires to the liquid helium was measured to assure that the temperature difference between sample and bath is not significant. It was found that the bubbles rising from a heater at the bottom of the Dewar simulate a forced convection which greatly increases the heat transfer coefficient and makes it independent of the temperature difference between sample and bath. It was observed that this temperature difference fluctuates at least by 10% of its value, and probably by a considerably larger amount. Measurements on a tin-coated manganin wire showed that a heating of the wire displaces the critical curve, but does not give rise to a hysteresis. Below 3.4° K hysteresis occurred which was not connected to the heating and which can probably be explained in terms of Ginsburg's phenomenological theory of superconductivity. A device for maintaining the temperature of the helium bath constant within a millidegree is described. A.

537.312.62 : 538.222

8785. PARAMAGNETIC EFFECT IN SUPERCONDUCTORS. VI. RESISTANCE TRANSITIONS IN INDIUM WIRES. H.Meissner and R.Zdanis.
Phys. Rev., Vol. 109, No. 3, 681-5 (Feb. 1, 1958).

For Pt V see preceding abstract. The resistance of indium wires from 0.04 to 2 mm in diameter was measured as a function of the current, in the temperature region from 2.9° to 4.2° K. The samples had residual resistance ratios $r_0 = R_{0\,°K}/R_{0\,°C}$ of 2 to 7×10^{-4}. For all samples, the transition curves measured showed a steep rise with a break at the critical current. The ratio of critical resistance to the normal resistance is examined as a function of temperature, electronic mean free path and sample diameter. Corrections are made for the temperature and magnetic-field dependence of the resistivity. A.

537.312.62 : 538.222

8786. PARAMAGNETIC EFFECT IN SUPERCONDUCTORS. VII. SHAPE OF THE SUPERCONDUCTING DOMAINS. H.Meissner.
Phys. Rev., Vol. 109, No. 5, 1479-85 (March 1, 1958).

For Pt VI see preceding abstract. A recalculation of the density of the domains in the paramagnetic effect for large values of the ratio of length to diameter of the domains shows that, except for a thin layer near the surface, the density is always very small. Under these conditions the current through a single domain becomes too large to be neglected. From whatever point of view one considers the effect of this current, one will conclude that it will lower the value of the mean magnetic field between the domains below the value of the bulk critical field. Assuming that the same conditions persist in absence of an external longitudinal field, one can explain the increase of the critical resistance above one-half of the normal resistance and its dependence on electronic mean free path, sample diameter, and temperature. An experimental study of the magnetic field in the centre of a hollow indium wire and the longitudinal flux in a solid indium wire reveals that the paramagnetic effect gradually disappears at external fields below 0.5 A/cm. This necessitates the assumption of disturbing influences which prevent the perfect alignment of the superconducting domains. It is believed that the disturbing influences, rather than the difference between the mean magnetic field and H_C, will lead to the corrections necessary to account for the observed limiting current I_g. A detailed treatment of the size of the domains and of their distribution should be made with the use of the thermodynamics of irreversible processes. A.

537.312.62 : 536.631

8787. HEAT CAPACITY IN THE NORMAL AND SUPERCONDUCTING STATES AND CRITICAL FIELD OF NIOBIUM. Chien Chou, D.White and H.L.Johnston.
Phys. Rev., Vol. 109, No. 3, 788-96 (Feb. 1, 1958).

The heat capacity of a vacuum-annealed sample of niobium was determined in the temperature range 1.5 to 30° K. The heat capacity measurements in the normal state below the transition temperature were carried out in magnetic fields up to 4130 gauss. The effect of vacuum annealing on the heat capacity, transition temperature, and critical field was determined in an effort to obtain a so-called ideal superconductor. After the initial annealing, within experimental error, the heat capacity in the superconducting state was found to be independent of further treatment. In the normal state the heat capacity (C_n) can be represented by the relation

$$C_n = 0.0018T + 464.4\,(T/\theta)^3,$$

where θ varies from 256 to 320 degrees depending on the temperature for the best annealed sample. No simple relationship holds for the heat capacity in the superconducting state. The heat capacity data could not be fitted to any existing corresponding state theory for superconductors. The zero-field transition temperature (T_C) and the critical field (H_C) were found to depend on the extent of annealing. For $T_C = 9.07°$ K, $(dH_C/dT)_{T=T_C} = 1148$ gauss deg^{-1} whereas for $T_C = 9.17°$ K, the highest transition temperature measured, $(dH_C/dT)_{T=T_C} = 734$ gauss deg^{-1}. From the heat capacity data $(dH_C/dT)_{T=T_C} = 415$ gauss deg^{-1} and H_0, the critical field at absolute zero = 1944 gauss. It was not possible by vacuum annealing, even at 2100° C, to obtain an "ideal" superconductor. A

537.312.62 : 536.631

8788. HEAT CAPACITY IN THE NORMAL AND SUPERCONDUCTING STATES AND CRITICAL FIELD OF TANTALUM. D.White, Chien Chou and H.L.Johnston.
Phys. Rev., Vol. 109, No. 3, 797-802 (Feb. 1, 1958).

The heat capacity of a vacuum-annealed sample of tantalum was measured in the normal and superconducting state from 1.3 to 25° K. In the normal state the heat capacity C_N can be represented by the expression $C_N = 0.00136T + 464.4(T/\theta)^3$, where θ varies from approximately 255 degrees at the lowest temperature to 220 degrees at the highest. The zero-field transition temperature, T_C, and the critical field H_C were determined using a calorimetric method. The value of T_C was found to be 4.39° K. The width of the transition was approximately 0.03° C. The measured critical field was within experimental error comparable to the calculated from the heat capacity data. The tantalum sample therefore exhibited the properties o

an ideal superconductor characteristic of the so called soft superconductors. The critical field at the absolute zero, from an extrapolation of the critical field data, was found to be 780 gauss. A.

537.312.62 : 537.311.4

8789. MEASUREMENTS ON SUPERCONDUCTING CONTACTS. H.Meissner.
Phys. Rev., Vol. 109, No. 3, 686-94 (Feb. 1, 1958).

The contact resistance between crossed wires was measured as a function of the current at various temperatures in the liquid-helium range. Most contacts were stable enough to establish a "diagram of state", i.e. determine curves of constant resistance in I–T space. The following facts were established: (1) The critical temperature of contacts between clean wires of tin is suppressed by about 0.2°K due to the pressure on the contact; (2) The addition of a copper layer on one or both of the wires reduces the critical currents, but hardly influences the critical temperature. This can be understood if one assumes that the density of the superconducting electrons decreases in the copper layer, thus producing an increase in the penetration depth. At layer thicknesses of several hundred angstroms the penetration depth becomes large compared to the contact radius, and the critical current v. temperature curve approaches that of a very thin wire; (3) Contacts between tin and copper wire below the critical temperature and at low currents show a constant resistance, which rises sharply at a critical current. Graphs of this quasi-critical current as a function of the temperature were obtained; (4) Clean contacts between tin and indium usually behave as one would expect from the foregoing. In one case out of three, however, the resistance was strongly dependent on the current at a temperature as high as 4.2°K. Plotting the low-current values of the resistance as a function of the temperature showed a behaviour as if one of the contact materials had a critical temperature of 5 to 6°K. A search of the literature revealed that the Sn–In system has two intermetallic compounds. The compound In_6Sn_2 was prepared, and was found to have a critical temperature of about 5.5°K. Since the contacts were closed at 4.2°K and no possibility of transfer of metal from one side to the other existed, it must be assumed that the proximity of the tin to the indium is sufficient to produce partial superconductivity by way of long-range correlation of the electronic wavefunctions. A.

537.312.62

8790. THEORETICAL INVESTIGATION OF THE STABILITY OF A CYLINDRICAL PHASE-BOUNDARY BETWEEN SUPER AND NORMAL CONDUCTOR IN A CIRCULAR MAGNETIC FIELD. B. BEHAVIOUR FOR VIRTUAL, FINITE, SPATIALLY-PERIODIC DISPLACEMENTS OF THE BOUNDARY.
N.Näbauer and G.U.Schubert.
Z. Phys., Vol. 151, No. 4, 431-59 (1958). In German.

For Pt A, see Abstr. 9701/1957. It is shown that the instability which results from the London theory, if the effect of interphase surface energy is neglected (l.c.), also persists if finite displacements are considered. H.London

537.312.62 : 548.736.3

STRUCTURE OF SUPERCONDUCTORS. See Abstr. 8529-30

537.323

8791. THERMOVOLTAIC EFFECT IN GAMMA-IRRADIATED BOROSILICATE GLASS. B.Gross.
Phys. Rev., Vol. 110, No. 2, 337-8 (April 15, 1958).

Borosilicate glass was irradiated with a high dose of gamma-rays from a cobalt-60 source. After irradiation the glass was heated while a temperature gradient was maintained between its surfaces. During the heating an external current was observed. The direction of the current in the dielectric corresponded to a transport of negative charge to the electrode with the higher temperature. A.

ELECTRIC DISCHARGES

537.521.7 : 621.387

8792. INVESTIGATION OF THE SPARKING POTENTIAL OF AN H.F. DISCHARGE IN A GAS IN THE TRANSITION RANGE OF FREQUENCIES AND PRESSURES. S.M.Levit-skiĭ.
Zh. tekh. Fiz., Vol. 27, No. 5, 970-7 (1957). In Russian.

In the frequency and pressure range where the amplitude A of the electron oscillations becomes comparable with width of discharge gap d, formation of the discharge is localized in a region of width d – 2A, called the "virtual discharge gap". This oscillates at the frequency of the field between the electrodes. The sparking potential calculated using this concept agrees satisfactorily with the experimental results. A discontinuity on the sparking characteristic divides two ranges of glow discharge with different mechanisms.
Electrical Research Association

537.523.4 : 621.317.72 : 621.319.53

8793. APPARATUS FOR PRODUCING AND MEASURING HIGH-ENERGY ELECTRICAL DISCHARGES. W.E.Richeson.
Rev. sci. Instrum., Vol. 29, No. 2, 99-104 (Feb., 1958).

Circuitry is described that is capable of delivering sparks with current pulses adjustable from square-wave to damped-oscillatory form, and having energies up to 100 J, peak currents to 50 000 A, and rise-times less than 2 μsec. To observe the spark current, a differential measurement scheme was developed. This eliminates errors inherent in establishing reference grounds, provides a method of reducing high-frequency and high peak-current distortions inherent in current viewing shunts, and provides a method of determining the potential across a spark gap. Electrical characteristics of spark discharges in a saturated NaCl–H_2O solution, as well as the rate of growth of the luminous plasma of a spark in air, are described to illustrate the flexibility and general characteristics of the spark circuitry and the differential measurement scheme. A.

537.525.3

8794. ON THE EFFECT OF A DOUBLE GRID ON CHARGE CARRIERS IN A NON-SELF-MAINTAINED DISCHARGE. H.Kessemeier.
Z. Phys., Vol. 150, No. 3, 272-6 (1958). In German.

Describes the use of a double grid mounted between anode and cathode in a uniform field transient discharge gap. The grid potentials can be arranged with respect to the gap system so that positive ions are held back and electrons transmitted. In this way, by elimination of positive-ion γ-effects at the cathode, single avalanches of super-normal size can be produced. J.D.Craggs

537.525.3

8795. ELECTRON PRODUCTION IN THE GASES N_2, H_2 AND O_2 AT LOW PRESSURES (P.D. ~ 50 mm cm). K.J.Schmidt-Tiedemann.
Z. Phys., Vol. 150, No. 3, 299-310 (1958). In German.

An oscillographic study of avalanches at lower p.d. (pressure × gap length) values than in the previous similar work by Vogel and Raether. Secondary ("γ") mechanisms were studied with reference to secondary electron production by photons and positive ions. Cathodes of Cu, W, and Ni, with or without oxidation, were used. Values of γ are tabulated for N_2 and H_2. J.D.Craggs

537.525.3 : 537.564

8796. INVESTIGATION ON THE "GAS-IONIZING" RADIATION OF A DISCHARGE. A.Przybylski.
Z. Phys., Vol. 151, No. 3, 264-80 (1958). In German.

The construction is described of an ionization chamber with a rotational ellipsoid shape, designed to measure the absorption coefficient μ of "gas-ionizing" radiation and avoid the complicating effects of the liberation of electrons from electrodes by radiation. The radiation from a corona discharge in O_2 was studied by this means. It was found that at gas pressures in the range from 10 to 30 mm Hg, radiation with $\mu_{760} = 38$ cm^{-1} reached the ionization chamber; the number of photons produced per electron in the discharge was also obtained as 6 to 3×10^{-4}. At gas pressures < 10 mm Hg two further components of radiation with μ_{760} estimated as about 250 and 550 cm^{-1} penetrated to the chamber. Results are also given for air–argon and air–argon–alcohol mixtures. J.Dutton

537.527.4

8797. RADIATIVE CHARACTERISTICS OF HIGH PRESSURE HYDROGEN SPARK DISCHARGES. M.McChesney and J.D.Craggs.
J. Electronics and Control, Vol. 4, No. 6, 481-92 (June, 1958).

Time-resolved spectrographic measurements of sparks in hydrogen at pressures of 5-150 lb/in^2 gauge are described. The discharges had a rectangular current waveform of 200 and 500 A and a duration of 1.5 and 2 μsec. The effect of pressure on the afterglow duration and the ionic concentrations during and after the discharge were measured from the Stark broadening of the H_α and H_β Balmer lines. Some discussion of spark-to-spark fluctuations in the light intensity of electrically identical discharges is given. D.Walsh

537.527.4

8798. OBSERVATIONS ON HIGH-TENSION SPARKS. S.Magun and S.Woerner.
Z. angew. Phys., Vol. 10, No. 1, 41-3 (Jan., 1958). In German.

High-intensity light emission during short times with lower limit of 10^{-7} sec is obtained by discharging a 450 kV van de Graaf generator through nitrogen and argon at pressures up to 20 atm. The time dependence of the light emission is studied by means of a rotating mirror driven by a Beams air-turbine. H.Motz

537.529 : 539.2

8799. NUCLEATION OF DISLOCATIONS ACCOMPANYING ELECTRIC BREAKDOWN IN LiF CRYSTALS.
J.J.Gilman and D.W.Stauff.
J. appl. Phys., Vol. 29, No. 2, 120-7 (Feb., 1958).

"Dislocation Lichtenberg figures" were discovered on the surfaces of LiF crystals subjected to high inhomogeneous electric fields. The figures consist of thousands of dislocation loops arranged along [100] dendritic branches which are terminated by [110] branches. Etching is necessary to reveal the figures. It is shown that electric fields can nucleate dislocations in LiF crystals. A.

537.529 : 539.234

8800. ELECTRIC BREAKDOWN OF CdS EVAPORATED LAYERS.
K.W.Böer, U.Kümmel and W.Misselwitz.
Naturwissenschaften, Vol. 45, No. 14, 331 (1958). In German.

The breakdown field strength of evaporated CdS layers with the Cu base as one electrode and a Hg drop as the other, increased from 10^5 V/cm at 2000 mμ (the bulk value) to about 8×10^5 V/cm at 75mμ thickness. Breakdown fields with the Hg electrode negative were 30% higher than for the reverse polarity. J.Franks

537.529 : 621.315.614.6 : 621.315.616.9

8801. DISCHARGE WITHSTAND STRENGTH OF SOME ORGANIC MATERIALS. M.M.Mikhaĭlov and Lyu Tszŷ-yuĭ.
Zh. tekh. Fiz., Vol. 27, No. 5, 940-7 (1957). In Russian.

Soviet-produced organic insulating materials: polymers and composite insulation (impregnated glass tissue and cable paper), were investigated in a circuit suggested by Dakin and comprising a partial-discharge indicator. Empirical laws relating intensity of partial discharges with applied voltage were found. A classification of the materials according to discharge withstand strength is given, headed by polystyrene, dry compound-impregnated cable paper and polyethylene; the poorest materials are dry (non-impregnated) paper and "fluoroplast-4". Electrical Research Association

X-RAYS

537.531 : 535.343

8802. SOFT X-RAY ABSORPTION EDGES OF METAL IONS IN COMPLEXES. III. ZINC (II) COMPLEXES.
F.A.Cotton and H.P.Hanson.
J. chem. Phys., Vol. 28, No. 1, 83-7 (Jan., 1958).

For Pt II, See Abstr. 438 (1957). The K X-ray absorption edges of the Zn^{+2} ion in various complexes were measured with a two-crystal spectrometer. The significance of the fine structure of these edges with regard to the stereochemistry and electronic structure of the complexes is discussed. A.

537.531 : 535.343

8803. SINGLE-CRYSTAL ORIENTATION EFFECTS IN K X-RAY ABSORPTION SPECTRA OF Ge.
J.M.El-Hussaini and S.T.Stephenson.
Phys. Rev., Vol. 109, No. 1, 51-4 (Jan. 1, 1958).

The extended fine structure of the short-wavelength side of the K X-ray absorption edge of a thin single crystal of Ge was studied for three different orientations of the crystal. Although the polarization was only 7%, shifts in the positions of the structure features were observed between 75 eV and 280 eV from the edge. These shifts are tabulated and discussed. A careful comparison of the absorption of a single crystal of Ge and a single crystal of an alloy of 7% Si in Ge was made to 60 eV from the Ge K-edge. Significant changes in the structure were noted as well as a probable shift in the position of the edge. A.

537.531 : 535.333

8804. PRECISION MEASUREMENT OF THE L X-RAY SPECTRA OF URANIUM AND PLUTONIUM. J.J.Merrill and J.W.M.DuMond.
Phys. Rev., Vol. 110, No. 1, 79-84 (April 1, 1958).

Twenty uranium L X-ray transitions were measured using a commercial, sealed off, uranium target X-ray tube. Twelve plutonium L X-ray transitions were measured in conventional X-ray fluorescence from a 5.86 g sample. All lines were measured with high precision using the two-crystal spectrometer, and corrected for the effects of temperature on the grating space of calcite, the effects of vertical divergence, and the effects of crystal diffraction pattern asymmetry. The wavelengths corresponding to these transitions are given in terms of the X-unit (where the latter is so defined that the wavelength of the Mo K_{α_1} line is 707.8490 X-units) with relative errors of less than 55 parts per million in the case of U, and less than 30 parts per million in the case of Pu. A.

537.531 : 535.41

8805. INTERFERENCE OF DIVERGENT X-RAY BEAMS ON THIN PLANE-PARALLEL FILMS. W.Hink and W.Petzold.
Z. angew. Phys., Vol. 10, No. 3, 135-8 (March, 1958). In German.

A microfocus of about 3 μ diameter, produced on a copper foil anticathode by suitable magnetic focusing, or by stopping down a a somewhat larger focus (70 μ diameter), was used as a source of X-rays for producing interferences on thin plane-parallel films of aluminium on a glass substrate with divergent X-ray beams. The film thickness can be calculated from the angular position of the interference maxima. This arrangement is a considerable simplification on that proposed by Kiessig (Abstr. 136/1932) and requires exposure times only 1-2% of those required by his method, though the accuracy is not inferior. The probable accuracy of the method is discussed. R.C.Murray

CATHODE RAYS. POSITIVE RAYS

537.533 : 537.542 : 621.385.833

8806. INVESTIGATION OF THE PERVEANCES AND BEAM PROFILES OF AN APERTURE DISK EMISSION SYSTEM.
E.R.Harrison.
J. appl. Phys., Vol. 29, No. 6, 909-13 (June, 1958).

Argon ion beams were used for determining experimentally the perveances and the associated beam profiles of a series of electrode structures consisting of coaxial aperture disks. The results are of particular interest in the design of ion sources. The results should also be of interest in the design and study of electron guns. Electron guns producing convergent beams, and designed on the Pierce principle of rectilinear flow, require electrodes whose shape is not always easy to reproduce or the most convenient to use. If the principle of rectilinear motion is abandoned, it is found experimentally that the perveance in many cases is little affected by the adoption of the much simpler electrode system of coaxial aperture disks. Perveance is the ratio of the output current to the $\frac{3}{2}$ power of the input voltage. A

537.533 : 537.534

8807. A CONSTANT FREQUENCY CYCLOTRON WITH ONE DEE
R.Bock, A.Doehring, J.Jänecke, O.Knecht, L.Koester, H.Maier-Leibnitz, C.Schmelzer and U.Schmidt-Rohr.
Z. angew. Phys., Vol. 10, No. 2, 49-55 (Feb., 1958). In German.

The construction and properties of a cyclotron in which the greater part of one of the D's has been removed is described. This asymmetric version allows greater freedom of manoeuvre inside the evacuated chamber than does the conventional arrangement, and also leads to simplification and greater efficiency of the power supplied and deflecting system. D-voltages of 100 kV and deuteron currents of 0.5 mA are typical. A.E.I. Research Laboratory

537.533 : 537.534 : 621.384.6

8808. DESIGN OF LINEAR ELECTRON ACCELERATORS WITH BEAM LOADING. R.B.Neal.
J. appl. Phys., Vol. 29, No. 7, 1019-24 (July, 1958).

The optimum design of linear electron accelerators depends upon the degree of beam loading. With very light loading, the product of the radio-frequency attenuation constant I and the accelerator length L should be approximately 1.26 for maximum beam energy in a given length. For heavier loading the product IL must be reduced to produce maximum electron energy and maximum conversion efficiency from radio-frequency power to electron beam power. The attenuation constant I can be chosen by the proper selection of the dimensions of the accelerating structure. Expressions and design curves are given for the optimum values of IL to maximize electron beam energy and electron beam power as a function of beam loading. A

537.533 : 537.534

8809. ENERGY AND POWER RELATIONS IN THE LINEAR ACCELERATOR. M.Wutz.
Z. angew. Phys., Vol. 10, No. 6, 268-72 (June, 1958). In German.

The linear accelerator of Wideroe (Abstr. 720/1929) has been

neglected in favour of later designs. However, it appears to have advantages for ion energies up to 100 MeV. Expressions are obtained from which optimum design may be deduced. The multi-stage form of the instrument operated at high frequency appears to have a promising performance. A.E.I. Research Laboratory.

537.533.2 : 536.654

8810. THE VARIATION WITH ATOMIC NUMBER OF THE WORK FUNCTION OF AN ELECTRON AND ATOMIC HEATS OF SUBLIMATION OF METALS. H.S.Mykhailov and O.Ya.Usikov.
Ukrayin. fiz. Zh., Vol. 2, No. 4, 380-2 (1957). In Ukrainian.

Current information is summarized on a graph.

C.R.S.Manders

537.533.3 : 621.385.1.029.6

8811. STABILITY OF AN ELECTRON BEAM ON A SLALOM ORBIT. J.S.Cook, W.H.Louisell and W.H.Yocom.
J. appl. Phys., Vol. 29, No. 3, 583-7 (March, 1958).

A study is made of an electrostatic method of focusing an electron beam in a travelling wave tube in which the beam traverses a "slalom"-like orbit between the wires of the slow wave structure. The requisite field is produced by a row of equally spaced wires at the same potential placed midway between two parallel plates at another potential. The equations of motion are solved to find initial conditions for stable orbits. Space charge effects are considered. A large "slalom" tester was built to compare experimental and theoretical results. The agreement between the computed and measured current transmitted is surprisingly close. There is also good agreement between the measured and computed beam perveance.

A.

537.533.332

8812. ISOTROPIC AND ANISOTROPIC DISTORTION OF WEAK MAGNETIC ELECTRON LENSES. R.Gobrecht.
Exper. Tech. der Phys., Vol. 6, No. 3, 97-109 (1958). In German.

In an apparatus for the measurement of magnetic lens image distortion, the eccentrically located electron source is made capable of rotation about the optical axis. The position of the image point for various orientations is measured and the rotational and radial components of the distortion are deduced.

A.E.I. Research Laboratory

537.533.7

8813. REFINED MEASUREMENT OF DISCRETE ENERGY LOSSES IN 30 keV ELECTRONS IN GASES. W.Dietrich.
Z. Phys., Vol. 152, No. 1, 87-97 (1958). In German.

Using a high resolution electron velocity spectrometer the author has confirmed the anomalous increase of energy spread in a beam of primary electrons at high current densities. To ensure a resolution of 0.25 eV with barium oxide cathodes the current must not exceed 2 μA; the corresponding resolution with a tungsten cathode is 0.4 eV. The discrete energy loss spectrum has been re-determined for N_2 and O_2 molecules and for He, Ne, A, Kr, Xe atoms. The atomic spectra are in good agreement with optical spectra. A.E.I. Research Laboratory

537.533.74

8814. BACKSCATTERING OF 5-20 keV ELECTRONS FROM INSULATORS AND METALS. J.E.Holliday and E.J.Sternglass.
J. appl. Phys., Vol. 28, No. 10, 1189-93 (Oct., 1957).

Electron backscattering measurements were carried out on composite layers consisting of thin metal films deposited on base layers of widely different backscattering properties. At low primary energies the backscattered fraction η (energies > 50 eV) is found to be characteristic of the surface film. When the electron energy is such that the range in the surface material is equal to twice its thickness, a marked change in η occurs. At sufficiently high energies, η approaches the value for the base layer. Measurements of η as a function of energy were made for layers of Al–Au, Al–Ag and Al–C. These results led to a new method for measuring η for insulators using thin aluminum surface films (~ 200 A) to avoid charging. Data on LiF, $Zn_3(PO_4)_2$, KCl, RbBr and TlI above ~ 5 keV indicated agreement with the known values for metals of the same average atomic number, demonstrating that backscattering in the keV range and above is an atomic characteristic independent of the crystal structure or the conduction properties of the solid.

A.

537.533.74

8815. ENERGY LOSS AND SCATTERING OF FAST ELECTRONS IN Be, C AND Al. B.Ziegler.
Z. Phys., Vol. 151, No. 5, 556-62 (1958). In German.

A 32 MeV betatron was used to measure energy losses in Be, C and Al. The average energy loss and the "half-width" of the scattered energy distribution agree well with theory. Experimental difficulties were encountered in measuring losses at medium energies. At the higher atomic numbers the measured most probable energy loss was higher than that predicted in theory.

A.E.I. Research Laboratory

537.533.75

8816. ENERGY LOSSES OF ELECTRONS OF MEDIUM VELOCITY IN METALS. W.Brauer.
Ann. Phys. (Leipzig), Vol. 20, No. 7-8, 390-8 (1957). In German.

A transformation and Taylor series expansion is given of the integral I_0, occurring in the theory of secondary emission (Abstr. 3777/1956). This enables the author to estimate the range of validity of a quadratic energy-loss law of electrons of medium energy (few 1000 eV) in alkali metals in the case of umklapp processes. The author finds that the primary energy must be $>\sim$ 5000 eV. The linear law, applicable to lower energies, is also discussed. T.P.Brody

537.533.8 : 535.376

8817. EXCITATION OF SHORT INFRARED PULSES WITH HIGH REPETITION RATE BY ELECTRON BOMBARDMENT OF CUPROUS OXIDE. R.Frerichs and F.Weichman.
J. appl. Phys., Vol. 29, No. 4, 710-13 (April, 1958).

The infrared emission of Cu_2O under electron-bombardment was investigated. Lamps containing an electron-bombarded Cu_2O target emit a single band between 0.8 and 1.4 μ. They can be very accurately pulsed with the help of a built-in grid. The efficiency at 6500 V is about 4 to 5% of the electrical input. With improved cooling of the target such lamps should form a powerful source for repetitive μsec pulses of the near infrared spectral region which can be observed with photoemissive tubes and image converters.

A.

537.533.8

8818. MECHANISM OF SECONDARY ELECTRON EMISSION FROM MgO SINGLE CRYSTALS. N.R.Whetten and A.B.Laponsky.
J. appl. Phys., Vol. 29, No. 9, 1374 (Sept., 1958).

A calculation based on the experimental conditions employed demonstrates that a maximum secondary emission yield in the range 20-25, obtained from single crystals of MgO (Abstr. 7962/1957), is not due to field enhanced emission; the maximum field established across the crystal, due to electron bombardment, is 0.1 V/cm, which is too small to influence the secondary yield.

C.H.B.Mee

537.534

8819. PRODUCTION OF BEAMS OF POLARIZED PROTONS BY THE ACCELERATION OF PROTONS DERIVED FROM POLARIZED HYDROGEN MOLECULES. R.L.Garwin.
Rev. sci. Instrum., Vol. 29, No. 5, 374-6 (May, 1958).

A conventional Stern–Gerlach separation of hydrogen molecules is proposed for supplying a radio-frequency or P.I.G. ion source of standard type to produce microampere beams of polarized protons for acceleration in electrostatic accelerators, cyclotrons, etc. The long nuclear relaxation time of molecular hydrogen gas allows the accumulation of polarized protons (as molecules) for the production of microampere average beams by means of a pulsed ion source. The polarized protons after acceleration have the energy- and angular-spread characteristic of the machine with which they were accelerated. There is no apparent reason why polarized H^- may not be produced in the same strong-field r.f. ion source, accelerated in a weak field to preserve polarization and stripped in a tandem machine, all without significant depolarization.

A.

537.534.3

8820. INCLINATION AND CURVATURE OF DIRECTION- AND ENERGY-FOCUSING CURVES OF DOUBLE FOCUSING MASS-SPECTROGRAPHS. H.Liebl.
Z. Naturforsch., Vol. 13a, No. 6, 490-1 (June, 1958). In German.

The curves are calculated in parametric form, with the deviation of the particle mass from that focused at the double focusing point as a parameter. Inclination and curvature are calculated in second-order approximation, and formulae are given which allow calculation for any system. Applications to a number of field combinations found in the literature are given. H.Motz

537.534.3

8821. A NEW HIGH-INTENSITY MASS-SPECTROMETER FOR DETECTION OF ATOMIC AND MOLECULAR BEAMS. F.Bernhard.
Z. angew. Phys., Vol. 9, No. 2, 68-73 (Feb., 1957). In German.

Discusses requirements of an instrument suitable for measuring the small changes in intensity of molecular beams, occurring in

the determination of nuclear moments. Details are given of a design consisting of an electron–ion collision source, a magnetic mass-analyser and a scintillation counter. Special techniques of measurement are described, e.g. for separating effects of beam and residual-gas molecules of the same mass. Resolving powers of 170 are obtainable, and satisfactory working is possible at partial pressures down to 10^{-12} mm Hg. B.Meltzer

537.534.8

8822. ENERGY SPECTRA OF SECONDARY ELECTRONS EMITTED BY A METAL UNDER BOMBARDMENT WITH HIGH-ENERGY IONS. F.Pradal and R.Simon.
C.R. Acad. Sci. (Paris), Vol. 247, No. 4, 438-41 (July 28, 1958). In French.

Using a magnetic velocity analyser, the energy spectra of secondary electrons emitted by the metals Al, W, Cu, Co, Ta, Zn, Au, Mo, Ni and Pt under ion bombardment were determined. The bombarding ions had energies of the order of 10 keV. If I is the intensity of secondary electrons of energy V and I_0 the intensity for V = 0, it is found that a law of the form $I = I_0 \exp(-eV/kT)$ is obeyed, where T is a characteristic emission temperature for the metal investigated. T is practically independent of the energy of the incident ions, and varies from 3.2×10^4 °K for Al to 8.9×10^4 °K for Pt. C.H.B.Mee

537.534.8

8823. SPUTTERING OF SURFACES BY POSITIVE ION BEAMS OF LOW ENERGY. R.E.Honig.
J. appl. Phys., Vol. 29, No. 3, 549-55 (March, 1958).

Silver, germanium and germanium–silicon alloy surfaces were bombarded with the inert-gas ions Ne^+, A^+, Kr^+ and Xe^+, at energies between 30 and 400 eV. Primary-beam intensities between one and ten $\mu A/cm^2$ were obtained in an oscillating electron source of the Heil type. The secondary particles sputtered off, neutrals as well as positive and negative ions, were identified and recorded in a 180° mass spectrometer of 5.5 inch radius. They are partly background gases adsorbed on the surface, partly atoms and molecules characteristic of the sample. Among the latter particles, neutrals were about 100 times more abundant than those emitted as positive ions. Rather low yields (about one sample atom per 100 incident ions with 400 eV energy) and relatively high threshold energies (40-50 eV for an angle of 30° between beam and surface) are believed to be due to surface contamination. Retarding potential measurements showed that over 80% of the particles sputtered have initial energies of less than 5 eV. After bombardment, the Ge and Ge–Si surfaces showed oval-shaped hillocks, possibly due to appreciable carbon concentrations in the sample studied. If the effects of surface contamination can be reduced, this method promises to be useful in the analysis of solid surfaces. A.

537.534.8

8824. POSITIVE ION EMISSION FROM METAL SURFACES CAUSED BY ION-BOMBARDMENT. A.Riddoch and J.H.Leck.
Proc. Phys. Soc., Vol. 72, Pt 3, 467-70 (Sept., 1958).

A tungsten target which had been bombarded with argon ions was found to emit positive ions of the alkali metals on heating, as well as the desorbed gas. Potassium ions were most abundant, and were emitted after many bombardment–degassing cycles; the emission of sodium, caesium and rubidium ions became insignificant after a few cycles. No trace of argon ions was found in the emitted spectrum. The effect is interpreted as being due to impurities present in commercial W, K being the most abundant alkali metal impurity. It is suggested that the ion emission observed after bombardment by Bills (Abstr. 5084/1958) is also due to impurities in the target material. C.H.B.Mee

537.534.8 : 537.56

8825. ON THE THEORY OF BREMSSTRAHLUNG IN HIGH TEMPERATURE PLASMAS. G.Hettner.
Z. Phys., Vol. 150, No. 2, 182-97 (1958). In German.

Bremsstrahlung radiation from isothermal plasmas at temperatures up to 10^8 °K are accurately calculated. Investigations are made as to the important corrections which it is necessary to apply to estimates of temperature and frequency on account of the ultimate distortion of the ions and their final displacement. A method of applying these corrections is given. As an illustration the bremsstrahlung spectrum of a high-pressure mercury arc is calculated and compared with experimental results. C.G.Morgan

DISCHARGE TUBES. IONIZATION. THERMIONICS

537.54

8826. THE RADIAL DISTRIBUTION OF CONCENTRATION OF CHARGED PARTICLES IN A MAGNETIC ION SOURCE.
M.D.Habovȳch and Yu.V.Yermolovȳch.
Ukrayin.fiz. Zh., Vol. 2, No. 2, 165-74 (1957). In Ukrainian, with summaries (1 p.) in Russian and (½ p.) in English.

With increase of field there is a main discharge column of diameter approximately that of the cathode which consists of plasma pierced by fast primary electrons. An equation is derived for the radial distribution of the charged particles assuming that ionization is produced mainly by the fast primary electrons with neutralizatio of the positive space-charge taking place chiefly due to slow electrons. The electrons generated in the column leave it because of the radial diffusion (weakened by the magnetic field), the ions in the column leave it chiefly along the "potential groove" to the ends of th vessel. C.R.S.Mander

537.543 : 621.385.2 : 621.36

8827. ANALYSIS AND EXPERIMENTAL RESULTS OF A DIODE CONFIGURATION OF A NOVEL THERMOELECTRON ENGINE.
G.N.Hatsopoulos and J.Kaye.
Proc. Inst. Radio Engrs, Vol. 46, No. 9, 1574-9 (Sept., 1958).

The direct conversion of heat into useful electrical work witho utilization of moving mechanical parts was successfully achieved i a device called the thermoelectron engine. This device is a heat engine in the thermodynamic sense because the working fluid, an electron gas, receives heat at a high temperature, rejects heat at a lower temperature, and delivers useful electrical work to an external load. This heat engine is also a thermionic device in that th electron gas is produced by emission from a hot cathode in a vacuu and by absorption or condensation of the electrons on a colder anod at a higher negative potential. The basic principle underlying this heat engine is that a calculable fraction of electrons emitted from hot cathode possess sufficiently high values of emission velocity to overcome a retarding electrostatic potential barrier between catho and anode in a vacuum. Thus these electrons can transform their high initial value of kinetic energy into useful potential energy at the colder anode; this potential energy can then be utilized by connecting cathode and anode externally through a matched impedance in the form of a load. Hence, this engine utilizes a selection proce which results in a large value of output voltage per unit cell compared with the output of a thermoelectric generator per unit thermocouple. The important engineering aspects of this heat engine comprise: (1) the use of emissive surfaces which can be machined carefully to high tolerances and thus permit very small spacing between cathode and anode, of the order of 0.001 in. or less; (2) the heat transfer designs which can greatly reduce unnecessary heat losses at the required high temperatures. A brief analysis of the diode configuration of a thermoelectron engine is given to predict the performance of several models. A thermal efficiency of betwe 12 to 13% was attained based on measured power output and calcula ted values of heat input. Power outputs of the order of 1 W/cm^2 of emissive surface were measured. If the theory and the presently available data are used as a basis of extrapolation it appears that thermal efficiencies greater than 15% may be attained. The power output might reach values of the order of 10 to 30 W/cm^2 of emissive surface. Multi-plate designs also indicate the attainability of fairly large values of power output per total volume or per total weight of equipment. A

537.56

8828. STABILITY STUDIES WITH LONGITUDINAL MAGNETIC FIELD ON A STRAIGHT PINCHED DISCHARGE.
L.C.Burkhardt, R.H.Lovberg, G.A.Sawyer and T.F.Stratton.
J. appl. Phys., Vol. 29, No. 6, 964-7 (June, 1958).

Experiments on the effects of a longitudinal magnetic field on a linear pinched discharge indicate that the characteristic m = 0 short wavelength instabilities are suppressed by B_z fields, and that pinch life is lengthened. Measurements with a system of magnetic probes indicate that the remaining instability is a long wavelength m = 1 helix. Image converter photographs of the pinch development and the short wave-length instabilities are presented. A

537.56 : 532.

8829. QUANTUM STATISTICAL THEORY OF PLASMAS AND LIQUID METALS. R.D.Cowan and J.G.Kirkwood.
J. chem. Phys., Vol. 29, No. 2, 264-71 (Aug., 1958).

A Debye—Hückel type theory is described for an assembly of completely ionized atoms, the nuclei being treated classically and the electrons by the Thomas—Fermi method. The thermodynamic functions are derived by considering the Debye charging process, and the virial theorem is shown to hold. Numerical results are given for hydrogen and iron near normal solid densities, and are probably accurate only at high temperatures ($kT > 5$ eV for hydrogen and $kT > 100$ eV for iron). At these temperatures, the results do not differ greatly from those of the ordinary Thomas—Fermi theory of the atom except for the additional contributions of the nuclei. A.

537.56

8830. APPLICATION OF LANGMUIR'S ELECTRICAL PROBE TO THE DETERMINATION OF PLASMA PARAMETERS IN AN ELECTRICAL DISCHARGE. J.Grygołajtys.
Rozprawy Elektrotech., Vol. 3, No. 1, 3-38 (1957). In Polish, with summary (1 p.) in English.

An outline is presented of Langmuir's electrical probe theory and its assumptions are discussed. Sources of errors and the range of applicability of the method for determining plasma parameters are considered. The method is illustrated by investigations with plane and cylindrical probes in mercury vapour at low pressure. Z.Krasucki

537.56 : 535.338.334

BROADENING OF SPECTRAL LINES EMITTED BY IONS IN A PLASMA. See Abstr. 8682

537.562 : 533.7

8831. RELATIVE DETECTION EFFICIENCY OF LiBr AND $(LiBr)_2$. P.Kusch.
J. chem. Phys., Vol. 28, No. 6, 1075-8 (June, 1958).

The relative efficiency for the production of positive ions when LiBr and $(LiBr)_2$ are incident on a hot oxidized tungsten wire were determined. It is found that the ratio of the number of ions produced for the molecule $(LiBr)_2$ and the molecule (LiBr) is 2.0 ± 0.1. The result is consistent with the heretofore unverified assumption that has been made in the study of the thermochemistry of the vapours of the alkali halides. Effects arising from the long mean free paths of molecules in ovens used for such studies were observed and are discussed. A.

537.562 : 539.19

8832. MASS SPECTROMETRIC DETECTION OF TRIAZENE AND TETRAZENE AND STUDIES OF THE FREE RADICALS NH_2 AND N_2H_3. S.N.Foner and R.L.Hudson.
J. chem. Phys., Vol. 29, No. 2, 442-3 (Aug., 1958).

With a free radical mass spectrometer H, H_2, N, NH_2, NH_3, N_2, N_2H_2, N_2H_3, N_2H_4, and N_3H_3 were observed as the result of an electrodeless discharge in hydrazine, or when hydrazine is reacted with the products of a high-power microwave discharge in H_2 or N_2. If the discharge products are first condensed in a liquid nitrogen trap and then allowed to evaporate, tetrazene is also observed. On removing the liquid nitrogen, N_2 comes off first and continues to be evolved during most of the warmup period. N_2H_2 and NH_3 have apparently about the same vapour pressure and evaporate at the same time. N_3H_3 and N_4H_4 start showing up at about the same time, N_4H_4 going through its maximum before N_3H_3. From the ionization potential of NH_2 and the appearance potential of NH_2^+ from NH_3, the dissociation energy $D(NH_2\text{-}H)$ is 106 ± 3 kcal/mole. The dissociation energy for hydrazine $D(H_2N\text{-}NH_2)$ is 58 ± 9 kcal/mole. Combining the ionization potential of the free hydrazyl radical with the appearance potential of $N_2H_3^+$ from hydrazine gives the dissociation energy $D(H\text{-}N_2H_3) = 76 \pm 5$ kcal/mole. R.Schnurmann

537.562

8833. EQUILIBRIUM CHARGES OF FISSION FRAGMENTS IN GASES. C.B.Fulmer and B.L.Cohen.
Phys. Rev., Vol. 109, No. 1, 94-9 (Jan. 1, 1958).

The charge of a heavy ion which is moving through matter fluctuates about an equilibrium value determined by two competing processes: electron capture and electron loss. The fragments from nuclear fission are a unique source of heavy ions which may be studied experimentally to determine the influence of the various factors which affect the equilibrium charge. A magnetic analysis method was used to measure the equilibrium charges of median-mass light and heavy fission fragments in H_2, He, air, and A, and mass 97 fragments in He for wide ranges of fragment velocity and gas pressure. The data for the fragments in H_2, air, and A showed pressure effects on the equilibrium charge which yield estimates of the mean radiative lifetime of excited ionized fragments which agree within 25%, in contrast with previous estimates differing by a factor of 10. An experimental test of the Bohr assumption, that the equilibrium charge of a heavy ion is equal to the number of electrons whose orbital velocities are lower than the translational velocity of the ion, showed the assumption to be only a rough approximation. Measurements of equilibrium charge as a function of atomic number of the stopping gas agree with previous measurements. A.

537.562

8834. THE STATISTICS OF ELECTRON AVALANCHES IN UNIFORM FIELDS. III. H.Schlumbohm.
Z. Phys., Vol. 151, No. 5, 563-76 (1958). In German.

For Pt II, see Abstr. 7131 (1958). In the present paper more measurements are given and the electrical technique is described. Attention is directed to special cases where the usual statistics are not satisfied, (a) multiple avalanches, (b) at low p.d. (pressure × gap length) values, and (c) high gas amplification. Results, i.e. avalanche size statistics etc., are given for oxygen, alcohol, acetone, methane and methylal. J.D.Craggs

537.562 : 539.1.07

THE STATISTICS OF ELECTRON AVALANCHES IN PROPORTIONAL COUNTER TUBES. See Abstr. 8954

537.562 : 539.59

TRAPPING OF HELIUM IONS AND THE RE-EMISSION OF TRAPPED ATOMS FROM MOLYBDENUM. See Abstr. 8624

537.564 : 536.654

8835. FRAGMENTATION OF METHANE BY ELECTRON IMPACT, AND THE LATENT HEAT OF SUBLIMATION OF CARBON. J.D.Morrison and H.E.Stanton.
J. chem. Phys., Vol. 28, No. 1, 9-11 (Jan., 1958).

The ions produced in the fragmention of methane by electron impact have been found to be formed with initial kinetic energy. Taking this energy into account, the electron impact data on methane are shown to be compatible with the spectroscopically acceptable value of 171 kcal/mole for the latent heat of sublimation of carbon in agreement with the value obtained by direct measurement. A.

537.564

8836. IONIZATION AND DISSOCIATION OF NO_2 AND N_2O BY ELECTRON IMPACT. J.Collin and F.P.Lossing.
J. chem. Phys., Vol. 28, No. 5, 900-1 (May, 1958).

A comparison of values of the ionization potential of NO_2 derived from direct electron impact, from dissociative ionization of CH_3NO_2, and from the ultraviolet spectrum of NO_2, show large discrepancies. There is reason to believe that three different electronic states are involved. The ionization potential of N_2O as measured by electron impact is in good agreement with spectroscopic data. The appearance potential of O^+ ion from N_2O gives $D(NN - O) = 39.7$ kcal/M, in excellent agreement with the thermochemical value of 39.49 kcal/M. A.

537.564

8837. NEGATIVE ION FORMATION IN N_2O AND IN NO BY ELECTRON IMPACT. B.E.Knox and B.P.Burtt.
J. chem. Phys., Vol. 28, No. 6, 1256 (June, 1958).

537.564

8838. ELECTRON CAPTURE PROCESSES IN THE HYDROGEN HALIDES. D.C.Frost and C.A.McDowell.
J. chem. Phys., Vol. 29, No. 3, 503-6 (Sept., 1958).

The formation of negative ions by resonance capture processes of the type $XY + e = X + Y^-$, was studied for the hydrogen halides. A monoenergetic electron source was used and it was possible to determine the true shape of the resonance capture peaks in these cases. It was found that the negative ions appear at energies which are in agreement with recent values for the dissociation energies of the H—X bonds, and the electron affinities of the halogen atoms. A.

537.564 : 537.521.6

8839. NEGATIVE ION FORMATION AND ELECTRIC BREAKDOWN IN SOME HALOGENATED GASES. W.M.Hickam and D.Berg.
J. chem. Phys., Vol. 29, No. 3, 517-23 (Sept., 1958).

Utilizing a conventional electron gun and mass spectrometer, the formation of negative ions at low electron energies was investigated for a number of halogen containing gases used in electric breakdown studies. The SF_6^- peak is used as an energy calibration for establishing the appearance potential and the energy width over which capture occurs for the individual gases. It is found that the relative areas of the negative ion curves can be correlated with the electric strength of the gases. The results suggest that the formation of SF_5^-

rather than SF_6^- may be the important process in providing the relatively high electric breakdown value for SF_6. Electron attachment associated with SF_6 and CCl_4 is found to be an extremely sensitive function of the gas temperature. The gases investigated include CCl_4, CCl_3F, CCl_2F_2, $CClF_3$, CF_4, CF_3SF_5, SeF_6, C_2F_3Cl, $CHCl_2F$, CF_2Cl-CF_2Cl, and ClO_3F. A.

537.564

8840. DOUBLE ELECTRON CAPTURE AND LOSS BY HELIUM IONS TRAVERSING GASES. S.K.Allison.
Phys. Rev., Vol. 109, No. 1, 76-84 (Jan. 1, 1958).

A beam of pure He^{+++} ions was passed through a cell in which the gas pressure could be varied, and the emergent beam was examined for its He^0 and He^+ content. With helium and air in the cell, it was observed that He^0 persists to pressures so low that it could not have been formed except by double electron capture by He^{++} in a single collision. In hydrogen the double capture event is much less probable. The analogous experiment was performed with a helium atomic beam, and at 250 keV and 450 keV in air He^{++}, formed by double electron loss, was detected. In hydrogen and helium only upper limits for double electron loss could be established. These results, with values of the sums $(\sigma_{20} + \sigma_{21})$ and $(\sigma_{01} + \sigma_{02})$ measured in previous researches, made it possible to compute values of σ_{20} and σ_{02}, as in the following table.

Cross-sections in units of 10^{-17} cm^2 per atom

	Hydrogen		Helium		Air	
keV	σ_{20}	σ_{20}/σ_{21}	σ_{20}	σ_{20}/σ_{21}	σ_{20}	σ_{20}/σ_{21}
	Double electron capture					
150	1.1	0.04	5.7	0.30	11.8	0.24
250	0.87	0.06	2.7	0.19	5.2	0.15
350	0.20	0.03	1.1	0.10	2.1	0.09
450	0.12	0.05	1.1	0.15	1.3	0.08
	Double electron loss					
	σ_{02}	σ_{02}/σ_{01}	σ_{02}	σ_{02}/σ_{01}	σ_{02}	σ_{02}/σ_{01}
250	0.1 ± 0.1	~ 0.02	0.2 ± 0.2	~ 0.02	0.5 ± 0.4	0.02
450	< 0.1	< 0.01	< 0.2	< 0.01	1.3 ± 0.4	0.06

A table of the six charge-changing collision cross-sections for helium ions is presented. The equations needed to compute the change in the charge composition of e helium ion beam due to passage through a gas film are given. A.

537.564

8841. CHARGE EXCHANGE CROSS SECTIONS OF HYDROGEN PARTICLES IN GASES AT HIGH ENERGIES.
C.F.Barnett and H.K.Reynolds.
Phys. Rev., Vol. 109, No. 2, 355-9 (Jan. 15, 1958).

Measurements are reported of the cross-section for electron loss (σ_{01}) and electron capture (σ_{10}) for hydrogen atoms and ions traversing gases of hydrogen, helium, nitrogen, and argon. The kinetic energy of the particles was from 250 keV-1 MeV. Cross-sections for electron loss were determined by measuring the attenuation of a neutral monatomic hydrogen beam in a gas cell in which transverse electric field was present. The cross-section for electron capture was measured by determining the fraction of the beam in each charge state after passing through a "thick" gas target. The fraction of the neutral component to the charge-one component is equal to the ratio of the cross-sections for electron capture to electron loss. The velocity dependence of the cross-section does not follow a strict power law. In hydrogen the cross-section decreases approximately as v^{-10}, while for heavier target gases the velocity dependence is smaller, being $v^{-3.7}$ for argon at energies greater than 500 keV. The electron-loss cross-section has a $1/v^2$ dependence for gases of hydrogen and helium and a $1/v$ dependence for nitrogen and argon target gases. A.

537.564 : 539.12

8842. IONIZATION YIELD OF PROTONS IN NITROGEN AND ARGON. R.A.Lowry and G.H.Miller.
Phys. Rev., Vol. 109, No. 3, 826-31 (Feb. 1, 1958).

The total ionization yield of protons in nitrogen and argon gases was studied for energies in the range of a few to 250 keV. A large cylindrical ionization chamber was used for this study. The chamber was alternately operated as a proportional counter and an ionization chamber to measure the rate with which the protons entered the chamber and the total ionization produced by them, respectively. The results indicated a straight-line relation between the ionization yield and proton energy for energies above 75 keV in nitrogen and above 25 keV in argon. Straight-line plots of the data had slopes corresponding to 36.6 ± 0.7 eV per ion pair for nitrogen and 26.5 ± 0.5 eV per ion pair for argon. For argon the straight-line plot intercepted the energy axis at 1.4 ± 0.9 keV, indicating a slight ionization defect. A.

537.564 : 539.18

8843. SIMULTANEOUS IONIZATION AND EXCITATION OF HELIUM BY PROTONS. R.A.Mapleton.
Phys. Rev., Vol. 109, No. 4, 1166-72 (Feb. 15, 1958).

Born's approximation is used to calculate the cross-sections for ionization and simultaneous ionization and excitation of helium by collision with protons. A.

537.564

8844. NEGATIVE HELIUM IONS.
P.M.Windham, P.J.Joseph and J.A.Weinman.
Phys. Rev., Vol. 109, No. 4, 1193-5 (Feb. 15, 1958).

Negative helium ions were produced with an ion source previously used for negative hydrogen ion production. Positive helium ions pass through a charge-exchange tube filled with hydrogen gas and the resulting negative ions are magnetically analysed. The momentum spectrum indicates peak yields of negative helium ions in excess of 3.5×10^{-9} ampere under the conditions of this experiment. The yield of negative helium ions as a function of converter gas density suggests a possible mechanism for the creation of the negative helium ion. A.

537.564 : 539.12

8845. ABSOLUTE ENERGY TO PRODUCE AN ION PAIR IN VARIOUS GASES BY BETA PARTICLES FROM S^{35}. W.P.Jesse.
Phys. Rev., Vol. 109, No. 6, 2002-4 (March 15, 1958).

The author repeated recent experiments in which the absolute average energy W_β required to form an ion pair in various gases was determined for the beta-particles from S^{35}. The present experiments employ a new procedure, which eliminates almost entirely large correction terms necessary in the former ionization measurements. The two experiments are in good agreement and yield the modified values of 35.0, 24.6, and 33.9 eV/ion pair for W_β for N_2, C_2H_6, and air, respectively. A

537.564 : 539.18

8846. IONIZATION PRODUCED BY ATOMIC COLLISIONS AT keV ENERGIES. A.Russek and M.T.Thomas.
Phys. Rev., Vol. 109, No. 6, 2015-25 (March 15, 1958).

A phenomenological theory is developed which accounts for the ionization produced by single collisions between heavy atoms or ions at kiloelectron volt energies. The collision ionization is regarded as a two-step process. First, as the two electron distributions sweep through each other, a certain amount of energy is transferred by a friction-like mechanism from the kinetic energy of translation of the atoms to their internal degrees of freedom. Second, this transferred energy, which is analogous to heat energy, is statistically distributed among the electrons. The probability that any given number of electrons acquire more than the ionization energy is then computed by a straightforward statistical analysis. The probabilities that the collision products are in the various states of ionization are thereby calculated as functions of the collision parameters. This ionization mechanism is analogous to the evaporation of molecules from a heated liquid. The theory is compared with experiment for the case in which singly charged argon ions are scattered by neutral argon atoms at energies of 25, 50, and 100 keV. At each bombarding energy the probabilities of finding the detected atom in any of the charge states, from zero to seven times ionized, as functions of the angle of scattering are predicted with reasonable accuracy with only two adjustable parameters. A.

537.565

8847. MEASUREMENT OF THE RATE OF OPPOSITE [CHARGE]-EMISSION IN A DOUBLY IONIZED ELECTRIC FIELD.
Tran an Nhan.
C.R. Acad. Sci. (Paris), Vol. 246, No. 21, 3028-31 (May 28, 1958).
In French.

The rate of "opposite (charge)-emission" (Abstr. 2576/1947) defined as $k_1\rho_1/k_2\rho_2$ (k_1 and k_2 the mobilities of ions of opposite sign and ρ_1 and ρ_2 their charge densities) was measured experimentally for two cases: (1) a wire at high potential surrounded by a concentr cylinder the inside of which was coated with an insulating layer, and (2) two parallel wires with a high potential difference between them. J.Dutto

537.568

8848. ELECTRON RECOMBINATION COEFFICIENT MEASUREMENTS IN NITROGEN AT LOW PRESSURES.
A.C.Faire, O.T.Fundingsland, A.L.Aden and K.S.W.Champion.
J. appl. Phys., Vol. 29, No. 6, 928-30 (June, 1958).

Rate coefficients for recombination in nitrogen were determined experimentally with partial pressures ranging from 0.01 to 3.00 mm Hg. At the lower nitrogen pressures, inert gases were added as passive recoil agnets to reduce diffusion losses in the afterglow of a pulsed microwave discharge. The apparent value of the recombination coefficient obtained from these measurements is $1.2 \pm 0.2 \times 10^{-6}$ cm^3 sec^{-1} for an electron temperature of approximately 300° K. The coefficient is constant within the experimental error, except at very low partial pressures of nitrogen where a small linear decrease is observed. The probable causes for this deviation are discussed. The magnitude of the rate coefficient and other evidence suggests that dissociative recombination is the most likely loss mechanism. A.

537.568

8849. ELASTIC AND INELASTIC SCATTERING OF LOW-VELOCITY IONS: He^+ IN Ne, Ne^+ IN He, AND Ne^+ IN Ne.
W.H.Cramer.
J. chem. Phys., Vol. 28, No. 4, 688-90 (April, 1958).

Experimental results are presented for collisions in the energy range 4 to 400 eV of He^+ ions in neon and of Ne^+ ions in helium and in neon. Charge exchange was observed only in the case of Ne^+ in neon. Empirical potential functions for the interactions are tabulated and discussed. It is concluded that the $HeNe^+$ ion, if formed, would probably separate if subjected to impact at thermal energies. A.

537.568

8850. RATE OF RECOMBINATION OF NITROGEN ATOMS.
P.Harteck, R.R.Reeves and G.Mannella.
J. chem. Phys., Vol. 29, No. 3, 608-10 (Sept., 1958).

The rate of recombination of nitrogen atoms by three-body collision was determined at room temperature and 0.5-1.3 mm pressure. The nitrogen was dissociated (about 3-6% nitrogen atoms) in a condensed discharge and pumped continuously through a glass tube 4.2 cm i.d. and 2.5 m long. The atom concentration was measured at a given point by "titrating" the N atoms with NO which was introduced into the gas stream at this point which was a short distance from the discharge tube. The N atoms react essentially instantaneously with NO in this titration,

$$N + NO \rightarrow N_4 + O.$$

When excess NO is added, the unconsumed NO combines with the O atoms formed yielding the typical oxygen afterglow. If insufficient NO is added, however, the unconsumed nitrogen atoms react with the O atoms formed, yielding the typical blue colour of the NO bands,

$$N + O + M \rightarrow NO^* + M,$$

$$NO^* \rightarrow NO + h\nu(\beta, \gamma \text{ bands of NO}).$$

When the quantity of NO added essentially equals that of the N atoms, the gas is practically colourless. This gives the N atom concentration at this point. In order to determine the rate of recombination of the N atoms, the relative decrease in intensity of the yellow nitrogen afterglow was obtained by following the reaction along the tube by means of a photomultiplier. The intensity of the afterglow is known to be proportional to the square of the N atom concentration. With the decrease of N atoms as a function of time and with the absolute N atom concentration known at a given point, the rate coefficient could be determined. The over-all value of the rate coefficient for the recombination reaction,

$$N + N + M \rightarrow N_2 + M,$$

was determined by this experimental method to be

$$k = 1.72\,(\pm 0.17) \times 10^{-33} \text{ cm}^6/\text{molecules}^2 \text{ sec}.$$

The third body was nitrogen or argon; the rate coefficient was the same for both gases within the limits of error given. A.

537.572

8851. SURFACE IONIZATION PHENOMENA ON POLYCRYSTALLINE TUNGSTEN. J.Zemel.
J. chem. Phys., Vol. 28, No. 3, 410-13 (March, 1958).

By assuming the existence of patches of different work functions on the surface of tungsten filaments, the ratio of ions to atoms emitted from the total surface is computed by applying the Langmuir–Saha equation to each patch. From a suitable choice of the fraction of the surface covered by patches of work function ϕ_n, a good fit to published data is obtained. The significance of these patches in the interpretation of surface ionization data is discussed. A.

537.581

8852. A STUDY OF TUNGSTEN CATHODES WITH FILMS OF CALCIUM ON THEM. A.É.Dol'nikov.
Zh. tekh. Fiz., Vol. 28, No. 5, 1032-5 (1958). In Russian.

The thermionic emission in vacuo from an unthoriated tungsten cathode, on which a film of Ca atoms was maintained by evaporation from an auxiliary furnace, was investigated using an anode potential of 300 V. Increases of the emitted current, I, were observed, which were greatest when the film only partly covered the surface — the optimum degree of covering being less at T = 1105° K, than at T = 970° K (where T is the temperature of the tungsten). For T = 1490° and 1105° K, I could be increased by factors of 2×10^4 and 10^{11} respectively. If the atomic beam of Ca atoms was cut off at some stage, I decreased; it was shown that the diffusion of Ca into the interior of the wire before the beam was cut off and its diffusion out again before evaporating from the surface slowed down the rate of decrease of I; by prolonged prior exposure to the Ca beam the decrease can be made slower giving a more stable activated emission. K.F.Hulme

537.583 : 536.422.1 : 621.385.032.213.13

8853. MEASUREMENT OF INSTANTANEOUS ABSOLUTE BARIUM EVAPORATION RATES FROM DISPENSER CATHODES.
W.C.Rutledge, A.Milch and E.S.Rittner.
J. appl. Phys., Vol. 29, No. 5, 834-9 (May, 1958).

A simple procedure for determining the "instantaneous" absolute evaporation rate of barium from dispenser cathodes is presented. The method entails exposing a clean tungsten wire to a stream of barium and noting the time required to reach maximum emission. The sensitivity of the wire as a detector of total barium is established on an absolute basis by chemical calibration. It has been found that the wire sensitivity is a function of the barium oxide content of the evaporant stream. This fact may be employed to determine the oxide composition of the evaporant from wire emission-time measurements and a single chemical analysis. It is also possible to obtain approximate, instantaneous values of total barium and the fraction BaO at any time during tube life from wire emission-time measurements only. Calibration data are presented for almost the full range of Ba–BaO compositions. A.

537.585

8854. ON THE CONVERSION OF HEAT ENERGY INTO ELECTRICAL USING THERMIONIC EMISSION.
N.D.Morhulis and P.M.Marchuk.
Ukrayin. fiz. Zh., Vol. 2, No. 4, 379-80 (1957). In Ukrainian.

Critical observations on recent papers and further to a previous paper (Abstr. 7056/1958). C.R.S.Manders

COSMIC RAYS

537.591.8 : 539.17

8855. ASSOCIATED PRODUCTION OF A K^+-MESON AND A HYPERFRAGMENT.
Tsai-Chü, B.Chemel and S.Desprez-Rebaud.
Nuovo Cimento, Vol. 9, No. 1, 192-4 (July 1, 1958).

This event was found in cosmic-ray exposed emulsion. The K-meson was identified by the ionization-scattering method. The hyperfragment was probably Be_Λ^8. Kinematical arguments are used to suggest that the neutral primary of the star was a photon. R.H.W.Johnston

MAGNETISM

538.08 : 621.317.44

8856. STEADY-STATE AND PULSE MEASUREMENT TECHNIQUES FOR THIN MAGNETIC FILMS IN THE V.H.F.-U.H.F. RANGE. D.O.Smith and G.P.Weiss.
J. appl. Phys., Vol. 29, No. 3, 290-1 (March, 1958).

A v.h.f.-u.h.f. bridge consisting of two loops placed symmetrically in a rectangular coaxial cavity was used to study steady-state and pulse relaxation in thin (~ 1000 A) Permalloy films. For steady-state measurements a coaxial transformer converts the bridge output from balanced-to-ground to unbalanced-to-ground; measurements from 100 to 1500 Mc/s are possible. Pulse measurements utilize the ungrounded deflection plates of a wide-band travelling-wave

oscilloscope; pulse response to 2 mμsec can be resolved. Drive-pulse calibration is accomplished unambiguously by using some of the unique switching properties of films which have uniaxial anisotropy. A.

538.082.103 : 578.087.8

8857. FAST AND SENSITIVE MAGNETIC SUSCEPTOMETER FOR THE STUDY OF RAPID BIOCHEMICAL REACTIONS.
A.S.Brill, H. den Hartog and V.Legallais.
Rev. sci. Instrum., Vol. 29, No. 5, 383-91 (May, 1958).

A Rankine balance-type magnetic susceptometer, combined with a flow system, is described. The instrument can detect in one measurement a change in volume magnetic susceptibility of 5×10^{-12} e.m.u. The response time is adjustable down to a fraction of a second by means of an electronic servo system. The time resolution of the flow system is limited by the flushing time of the cell to 5 sec. A time resolution of hundredths of a second is feasible, as is the detection, in one measurement taking a second, of a change of 1.5×10^{-12} e.m.u. corresponding to the r.m.s. Brownian force arising from air resistance to the motion of the magnet. A.

538.083.9 : 539.1.07 : 621.317.444

8858. DIRECT QUARTZ CRYSTAL CONTROL OF A LOW-LEVEL POUND–KNIGHT–WATKINS SPIN MAGNETOMETER. R.J.Blume.
Rev. sci. Instrum., Vol. 29, No. 7, 574-7 (July, 1958).

A quartz crystal is placed in the feedback path of the marginal oscillator, between the cathodes of the oscillator tubes. This change results both in greatly improved frequency stability (2 parts in 10^7 per hr at 30 Mc/s with the simplest non-thermostatted crystal) and a useful increase of signal-to-noise ratio (although not necessarily of noise figure) owing to the r.f. filtering action of the crystal. Magnetometer operation at an r.f. level as low as 100 μV across the sample coil, equivalent to an r.f. field of about 5 μG, was obtained. A magnet servo based on the crystal-controlled magnetometer is discussed. A.

538.113

8859. FORCE ON AN ANISOTROPIC PARAMAGNETIC CRYSTAL IN AN INHOMOGENEOUS MAGNETIC FIELD. W.P.Wolf.
J. appl. Phys., Vol. 28, No. 7, 780-1 (July, 1957).

A simple expression is derived for the force exerted on an anisotropic paramagnetic crystal by a magnetic field having gradients in two perpendicular directions. It shows that there is in general no direct relation between the force on an isotropic and an anisotropic sample in the same field, so that care must be exercised in interpreting the results of susceptibility measurements on anisotropic crystals by the Faraday method. A.

538.113 : 536.631

8860. EFFECT OF EXCHANGE INTERACTION ON THE MAGNETIC AND THERMAL PROPERTIES OF COPPER SALTS AND COPPER COORDINATION COMPOUNDS. J.C.Eisenstein.
J. chem. Phys., Vol. 28, No. 2, 323-9 (Feb., 1958).

This paper has two purposes. The first is to derive general formulae for the specific heat and the susceptibility of a compound in which there are two magnetically inequivalent ions with effective spin $\frac{1}{2}$ in each unit cell. Dipole–dipole and anisotropic exchange interactions are taken into account in the derivations. The second purpose is to explore in a rather tentative way the possibility of applying the theory to a compound in which the magnetic ions are strongly coordinated to the surrounding anions. The compound selected for detailed study is copper tetrammine sulphate monohydrate. Experimental data on this compound are neither as extensive nor as accurate as one might wish, and the theory contains a large number of adjustable parameters. Consequently it is impossible to make sharp judgments about the values of the parameters. It is concluded, however, that exchange interactions have important effects on the magnetic and thermal properties of copper tetrammine sulphate. Other substances to which the theory might be applied are mentioned. A.

538.114

8861. ROTATIONAL MODEL OF FLUX REVERSAL IN SQUARE LOOP SOFT FERROMAGNETS. E.M.Gyorgy.
J. appl. Phys., Vol. 29, No. 3, 283 (March, 1958).

A brief review of the experimentally established details of the flux reversal process in square loop ferrites is given. The discrepancies between the experimental results and the predictions of the domain wall motion theory are discussed. The switching coefficient S_W is examined in detail. The rotation model is based on the solution of the modified Landau and Lifshits equation, but does not assume that the magnetization rotates uniformly throughout the sample. The model predicts the shape of the output voltage pulse, the relationship between the flux reversal time and the applied field and the minimum switching coefficient that can be obtained for a given ferrite. The switching coefficients determined experimentally for ferrites, permalloy tape, and thin evaporated metal films (with zero transverse field) are within a factor of three of the minimum value of S_W predicted by this model. A.

538.114

8862. FERROMAGNETIC DYNAMICAL RESPONSE. H.B.Callen.
J. appl. Phys., Vol. 29, No. 3, 333-4 (March, 1958).

A dynamical equation, describing the response of the magnetization to an applied field, is proposed. The analysis is based on a spin-wave picture. The dynamical equation contains three parameters, defined in terms of particular magnon–magnon and magnon-phonon transition probabilities. A more detailed theory for one of these parameters is developed. The resultant size and shape dependence of the magnetic loss is suggestive of experimental observations. A.

538.114

8863. RESONANT MODES OF FERROMAGNETIC SPHEROIDS.
L.R.Walker.
J. appl. Phys., Vol. 29, No. 3, 318-23 (March, 1958).

The spectrum of modes of oscillation of a ferromagnetic spheroid situated in a uniform d.c. magnetic field is discussed. It is shown that, for the size of sample usually used in microwave experiments, a part of the spectrum consists of magnetostatic modes for which exchange and propagation may be ignored. The behaviour of these modes is discussed at some length and it is shown that the analysis gives a satisfactory description of the observed absorption curves. A.

538.114

8864. EFFECT OF ELECTRONIC MEAN FREE PATH ON SPIN-WAVE RESONANCE IN FERROMAGNETIC METALS.
G.T.Rado.
J. appl. Phys., Vol. 29, No. 3, 330-2 (March, 1958).

It is suggested that under certain conditions the interpretation of ferromagnetic resonance phenomena in metals should not make use of Ohm's law because the electronic mean free path may not be negligible in comparison to an appropriately defined effective skin depth. Such conditions can exist even at moderately low temperatures provided the equivalent permeability is sufficiently large. The anomalous effects due to the mean free path are shown to be particularly important in spin-wave resonance, i.e. in a modified ferromagnetic resonance which is appreciably influenced by the exchange interactions existing in the skin depth. A suitable perturbation method is developed for calculating these anomalous effects on the basis of Maxwell's equations and the spin-wave equation. Using a relation proposed by Reuter and Sondheimer, a simple first-order result is then obtained for the surface impedance and for the equivalent permeability derived therefrom. The limitations of the underlying physical model are pointed out, and the applicability of the theory to existing experimental results is briefly discussed. A.

538.114

8865. INHOMOGENEOUS BROADENING OF MAGNETIC RESONANCE LINES. A.M.Clogston.
J. appl. Phys., Vol. 29, No. 3, 334-6 (March, 1958).

An inhomogeneously broadened magnetic resonance line is narrowed by dipole fields. The theory of this effect is developed in terms of the classical equations of motion of a magnetized medium by expanding the magnetization and fields into Fourier series. An expression is obtained for the imaginary parts of the susceptibility tensor. In the applicable range of the theory, the line width decreases inversely as the magnetization, and is strongly shape dependent. A.

538.114

8866. ORIGIN OF FERROMAGNETIC RESONANCE LINE BROADENING IN MANGANESE-RICH MANGANESE FERRITES.
S.E.Harrison, H.S.Belson and C.J.Kriessman.
J. appl. Phys., Vol. 29, No. 3, 337-8 (March, 1958).

Ferromagnetic resonance line-widths in dense polycrystalline and single crystal specimens, the magnetic moment and the anisotropy field (K_1/M_S) were measured as a function of temperature. Between room temperature and the Curie point the excess resonance line-width, which is given by ΔH (excess)–ΔH (polycrystal)–ΔH (single crystal), is found to have the same temperature dependence as the saturation magnetization. The result is obtained even though the polycrystalline density (> 98%) is sufficiently high to be

in the range where the excess line-width has usually been attributed to anisotropy broadening. In the region below room temperature ΔH (excess) becomes dependent on the anisotropy field. An approximate criterion, that is suggested by the data, to determine whether the anisotropy field or the magnetic moment is responsible for the broadening is the ratio $K_1/M_S^2 >$ or < 0.25. The compositions ured were $Mn_{1.24}Fe_{1.76}O_4$ and $Mn_{1.49}Fe_{1.51}O_4$. The polycrystalline g factor (g_p) is greater than the single crystal g factor (g_s) and both g factors are functions of the temperature. The shift in the polycrystalline resonance peak is discussed with reference to the Standley Stevens theory and limited agreement is found. The anisotropy constant, K_1, has been found to vary as the fifth power of M_S for these ferrite compositions. A.

538.114

8867. FERROMAGNETIC RESONANCE IN UNIAXIAL POLYCRYSTALLINE MATERIALS. C.A.Morrison and N.Karayianis.
J. appl. Phys., Vol. 29, No. 3, 339-40 (March, 1958).

A theoretical determination is made of the resonance curve of a nonconducting polycrystalline ferromagnetic material with uniaxial crystalline anisotropy. A finite intrinsic line width is assumed for the single crystal, and effects of grain boundaries, impurities, inhomogenieties, and volume and surface divergence of the magnetization are ignored. The results are compared qualitatively with experiment. A.

538.114

8868. FERROMAGNETIC RESONANCE IN POLYCRYSTALLINE NICKEL FERRITE ALUMINATE. E.Schlömann and J.R.Zeender.
J. appl. Phys., Vol. 29, No. 3, 341-3 (March, 1958).

Line broadening because of crystalline anisotropy and the random orientation of the crystallites is investigated for the case in which the anisotropy field is much larger than the saturation magnetization. The theory predicts an absorption line with shoulders on each side which correspond to grains in which a hard or an easy direction is aligned with the d.c. field. With increasing anisotropy the low-field side of the line becomes more prominent and for $\gamma H_a/\omega > \sim 0.5$ a secondary absorption peak occurs on the low-field side of the main resonance. Measurements in nickel ferrite aluminates at X-band agree reasonably well with the predictions, if it is assumed that the first-order anisotropy constant is negative and that all higher order anisotropy constants are zero. A.

538.114

8869. ORIGIN AND USE OF INSTABILITIES IN FERROMAGNETIC RESONANCE. H.Suhl.
J. appl. Phys., Vol. 29, No. 3, 416-21 (March, 1958).

An outline is presented of the behaviour of ferromagnetic materials in large high-frequency fields. It is shown that, because of the collective behaviour of the electronic spins, instabilities set in beyond a certain critical field amplitude. Finally, the application of such effects to the construction of ferromagnetic amplifiers is discussed. A.

538.114

8870. MULTIPLICITIES OF THE UNIFORM PRECESSIONAL MODE IN FERRIMAGNETIC RESONANCE.
I.H.Solt, Jr, R.L.White and J.E.Mercereau.
J. appl. Phys., Vol. 29, No. 3, 324-5 (March, 1958).

There exists some uncertainty connected with the uniform precessional mode. The uniform mode is of most importance since it is for this mode that values of line widths, g values, and anisotropy constants are usually quoted in the literature. It can be distinguished experimentally from the higher order modes since: (a) its intensity of absorption is proportional to the uniform component of the r.f. magnetic field over the sample and (b) its intensity decreases much less rapidly with diminishing sphere size than for the higher order modes. It is observed, however, that there are several lines possessing these characteristics of the uniform mode. The relative intensities of these lines are strong functions of both temperature and frequency, they have different anisotropy constants, and their separation decreases with sphere radius. Data exhibiting these properties are presented for experiments on spherical single crystals of MnZn ferrites performed in the microwave frequency range of 8000-12 000 Mc/s. A discussion of several possible mechanisms that might give rise to this phenomena is given. A.

538.114

8871. FERRIMAGNETIC RESONANCE IN GADOLINIUM IRON GARNET. B.A.Calhoun, W.V.Smith and J.Overmeyer.
J. appl. Phys., Vol. 29, No. 3, 427-8 (March, 1958).

Ferrimagnetic resonance in single crystals of gadolinium iron garnet was observed at 9479 and 23 725 Mc/s. Crystals from two different preparations have different compensation points (13° and 32° C). The resonance behaviour is discussed in terms of a two sublattice theory. g_{Gd} is equal to 2.006 above −90° C and increases at lower temperatures. The gadolinium ions contribute to the anisotropy below −40°. An extra resonance observed near the compensation point is attributed to inclusions in the crystals. The gadolinium apparently contributes substantially to the total damping of the magnetization. A.

538.114

8872. DAMPING AND THE DISPERSION RELATIONS IN ANTIFERROMAGNETIC RESONANCE. E.S.Dayhoff.
J. appl. Phys., Vol. 29, No. 3, 344-5 (March, 1958).

The tensor susceptibility of an antiferromagnetic with uniaxial anisotropy is calculated using several modifications of the Bloch damping term. The axial component of the susceptibility is particularly simple and is readily tested by the Kronig–Kramers dispersion relations as modified by Gourary (Abstr. 5449/1957). It is found that, of the damping terms considered, only one which includes relaxation to the instantaneous equilibrium magnetizations will pass this test. A.

538.114

8873. TEMPERATURE DEPENDENCE OF FERROMAGNETIC ANISOTROPY. W.J.Carr, Jr.
J. appl. Phys., Vol. 29, No. 3, 436-7 (March, 1958).

The temperature dependence of the crystalline anisotropy constants of iron, cobalt, and nickel is discussed. It is shown that Zener's result for iron (i.e. the first anisotropy constant varies as the tenth power of the magnetization) also may be derived from molecular field theory. In cobalt a satisfactory agreement with experiment is obtained by using Zener's results together with the postulate that the intrinsic anisotropy varies with thermal expansion in the manner recently calculated by the author. For nickel also the temperature dependence of K_1 seems to require, in addition to the tenth power of the magnetization, a multiplicative factor that is linear in the temperature. No explanation has been found for this latter term. A.

538.114

8874. ON THE THEORY OF DOUBLE BLOCH WALLS IN THIN FILMS. J.Kaczér.
J. appl. Phys., Vol. 29, No. 3, 569-72 (March, 1958).

A theory of the double Bloch walls observed by Williams and Sherwood (Abstr. 3239/1958) in thin ferromagnetic films. The stability of these walls as a function of the thickness of the film and the external magnetic field is discussed. A.

538.114

8875. THEORY OF ANTIFERROMAGNETIC–FERROMAGNETIC TRANSITIONS IN DILUTE MAGNETIC ALLOYS AND IN THE RARE EARTHS. G.W.Pratt, Jr.
Phys. Rev., Vol. 108, No. 5, 1233-42 (Dec. 1, 1957).

In a previous paper (Abstr. 5450/1957) a theory of direct exchange and superexchange coupling between d or f electrons and conduction electrons was given. This led to the possibility of an antiferromagnetic–ferromagnetic transition. The present paper is devoted to a more complete treatment of this magnetic transition by examining a particular case. Both the molecular-field theory and a cluster theory due to Oguchi (Abstr. 457/1956) are applied. Each leads to a magnetic transition and both predict that for all such transitions the ferromagnetic state must have a lower free energy at 0° K than the antiferromagnetic state. The transition is found to be of second order. Expressions are given for the parallel and perpendicular susceptibility in the neighbourhood of the Néel point. A discussion is given showing how the direct exchange interaction with the conduction electrons makes a magnetic transition possible. A comparison is made between the theory given here and recent experimental results in Cu–Mn alloys. A.

538.114

8876. EXCITATION OF SPIN WAVES IN A FERROMAGNET BY A UNIFORM R.F. FIELD. C.Kittel.
Phys. Rev., Vol. 110, No. 6, 1295-7 (June 15, 1958).

It is possible to excite exchange and magnetostatic spin waves in a ferromagnet by a uniform r.f. field, provided that spins on the surface of the specimen experience anisotropy interactions different from those acting on spins in the interior. For modes with an odd number of half, wavelengths should be excited in a flat plate. The definition of what is meant by a different anisotropy interaction is worked out and is a rather lenient condition. Experiments which would determine the exchange energy constant should be possible

using sufficiently thin platelets of single crystals having parallel faces. The theory may account for the observation by Waring and Jarrett of a large number of resonance peaks in $NiMnO_3$. A.

538.22 : 669

MAGNETOMETALLURGY — APPLICATIONS AND TECHNIQUES. See Abstr. 9198

538.221

8877. FERROMAGNETIC RESONANCE IN ULTRA-THIN FILMS. M.H.Seavey, Jr and P.E.Tannenwald.
J. appl. Phys., Vol. 29, No. 3, 292-3 (March, 1958).

A ferromagnetic film may be arbitrarily considered as "ultra-thin" when its thickness is less than 100 A. Microwave resonance absorption was observed in Permalloy films down to approximately 15 A thickness. The magnetization drops sharply near 60 A, and ferromagnetism disappears between 8 A and 12 A. Line shape and width and g factor were also measured. A.

538.221

8878. UNIAXIAL MAGNETIC ANISOTROPY INDUCED IN Fe—Ni ALLOYS BY MAGNETIC ANNEAL. E.T.Ferguson.
J. appl. Phys., Vol. 29, No. 3, 252-3 (March, 1958).

The uniaxial magnetic anisotropy induced in iron—nickel alloys by a magnetic anneal was determined as a function of the composition, annealing temperature and duration. It was found that the result is consistent with the Néel—Taniguchi theory. A.

538.221

8879. SPONTANEOUS MAGNETIZATION OF SOME GARNET FERRITES AND THE ALUMINUM SUBSTITUTED GARNET FERRITES. R.Pauthenet.
J. appl. Phys., Vol. 29, No. 3, 253-5 (March, 1958).

Magnetic properties are reported of $5Fe_2O_3 \cdot 3M_2O_3$, where M represents the Y ion or one of the ions of the series from Sm to Ln inclusive. The results are interpreted using Néel's molecular field model. A study of the Al substituted gadolinium garnets shows a preference for Al ions to occupy d-sites. A.

538.221

8880. MAGNETIC RESONANCE OF FERRITES WITH A COMPENSATION TEMPERATURE. J.Pauleve.
J. appl. Phys., Vol. 29, No. 3, 259-63 (March, 1958).

Calculations of the resonance fields as a function of temperature and of resonance frequency as a function of field for temperatures near the compensation temperature for lithium—chromium ferrite and gadolinium garnet are given. For the latter case, a comparison is made between the assumption of zero anisotropy and an assumed negative anisotropy. A.

538.221

8881. TRANSVERSE FLUX CHANGE IN SOFT FERROMAGNETICS. F.B.Humphrey.
J. appl. Phys., Vol. 29, No. 3, 284-5 (March, 1958).

Results of an investigation of magnetic flux change in the direction perpendicular to the direction of the applied field indicate that the maximum flux in the transverse direction does not occur at the time when the sample is half reversed. From these data, taken on thin evaporated films of iron—nickel, it is concluded that a coherent rotation theory which assumes a single magnetization vector to represent the entire sample is not adequate to explain the results. It is suggested that, when a small transverse field is present, the magnetization starts to reverse by coherent rotation but soon loses phase throughout the sample so that the reversal is completed by noncoherent rotation. With no transverse field, the coherence is never established and the reversal is completely by noncoherent rotation. Added evidence for this suggestion is presented in the form of a comparison of thin films with ferrite and permalloy tape cores. In both the normal and transverse directions, the observations are similar, supporting the view that the reversal of films and cores is by the same general mechanism. A.

538.221

8882. EFFECTS OF HEAT TREATMENT OF THIN FERROMAGNETIC FILMS AT INTERMEDIATE TEMPERATURES. E.N.Mitchell.
J. appl. Phys., Vol. 29, No. 3, 286-7 (March, 1958).

Iron—nickel films deposited in vacuo in the presence of a magnetic field were annealed in an inert environment. It was established that, when the annealing is performed in an orienting field of 30 Oe, initial magnetic properties of these films can be altered provided that the initial temperature is high enough. If a field is applied at right angles to the original preferred direction and in the plane of the film, the magnitude of the magnetic anisotropy can be reduced without changing the preferred direction; the preferred direction of magnetization can be changed if the anneal temperature is sufficiently high. A

538.22

8883. REVERSIBLE ROTATION IN MAGNETIC FILMS. R.M.Sanders and T.D.Rossing.
J. appl. Phys., Vol. 29, No. 3, 288-9 (March, 1958).

The magnetization of permalloy films of 0.1 to 0.3 μ thickness vacuum-deposited in a magnetic field is reversibly rotated by a pulsed external field applied at right angles to the direction of easy magnetization. The total angle of rotation is deduced from the amplitude of the detected signal or from the strength of the applied drive field. Reversible rotations of 60° or more are repeated for at least 10^8 cycles in some films. An excessive drive field results in a loss of remanent magnetization after a few rotations. High wall-motion coercivity is a necessary but not sufficient condition for large reversible rotation angles. Films giving a large rotation tend to have open hysteresis loops in the difficult direction. (See also following abstract.) A

538.22

8884. FURTHER OBSERVATIONS ON REVERSIBLE ROTATION IN MAGNETIC FILMS. R.M.Sanders.
J. appl. Phys., Vol. 29, No. 6, 1003-4 (June, 1958).

It has previously been reported (see preceding abstract) that positive and negative output signals of unequal amplitudes were observed with some Permalloy films driven with a pulsed field in the transverse direction, the detection of the flux change being made in the easy direction. It was then assumed that the unbalance was caused by the earth's field normal to the specimen, but it has now been shown that this is not correct, and that the unbalance is associated with the method of setting up the specimens. A.E. De Barr

538.22

8885. PHYSICAL AND MAGNETIC PROPERTIES OF ELONGATED SINGLE-DOMAIN IRON AND IRON—COBALT PERMANENT MAGNETS.
R.C.Lever, E.J.Yamartino and R.B.Falk.
J. appl. Phys., Vol. 29, No. 3, 304-6 (March, 1958).

The physical and magnetic properties of permanent magnets compacted from elongated single-domain particles with metal and organic matrices are described. Their unique properties which make possible novel design and application possibilities include: demagnetization curve flexibility; high-energy and energy-to-weight ratio; uniformity of pole face flux; low-temperature coefficient of remanence; precise dimensional tolerances; excellent machinability; solderability; low critical material content; and short radioactive half-life. Compacts have been prepared from iron and iron—cobalt particles with energies of 3.5 million and 5 million gauss-oersted, respectively. Compacts exposed to 100°C for over one year were observed to change remanence less than 1%. A

538.221

8886. LOSS OF EXCHANGE COUPLING IN THE SURFACE LAYERS OF FERROMAGNETIC PARTICLES. F.E.Luborsky.
J. appl. Phys., Vol. 29, No. 3, 309-10 (March, 1958).

Experiments with spherical iron particles 28 A to 265 A in diameter demonstrated that the proposed non-ferromagnetic surface layer on an iron particle must be less than 1 A thick, i.e. about one atomic radius. This conclusion is based upon a comparison of the ferromagnetic iron calculated from the magnetic saturation, and the total amount of iron as determined by chemical analysis. The 1/H extrapolation of the magnetic induction appears adequate to obtain the saturation induction at room temperature of particles greater than about 100 A in diameter. For particles less than this size, in the superparamagnetic size range, the Langevin function must be used taking into account the size distribution of the particles in the sample. Thus there will be a negligible decrease in saturation induction due to the loss of exchange coupling at the surface of iron particles in the size range above 100 A of interest for fine-particle permanent magnets. This is a slightly shorter version of Abstr. 2389 (1958). A.

538.221

8887. STUDY OF PRECIPITATE PARTICLES IN Cu—Co EMPLOYING FERROMAGNETIC RESONANCE. D.S.Rodbell.
J. appl. Phys., Vol. 29, No. 3, 311-12 (March, 1958).

Observations of the ferromagnetic resonance absorption of submicroscopic particles may be interpreted to yield useful information about anisotropies. The alloy 2% Co—Cu heat treated to precipitate cobalt containing about 10% copper from the nonmagnetic solid solu-

tion was studied using ferromagnetic resonance techniques. In the early stages of growth the precipitate particles are shown to be essentially spherical in shape. Further growth of the precipitate particles (by subsequent heat treatment) is accompanied by aspherical shape changes which modify the resonance spectra. The magneto-crystalline anisotropy of the cobalt precipitate in single crystals of this alloy was determined. This anisotropy is cubic with $K_1/M_S = -665$ Oe at room temperature. The cobalt-rich precipitate retains its cubic crystal structure to at least 4.2°K, apparently stabilized by the copper matrix. A.

538.221

8888. MAGNETIC DETERMINATION OF SHAPE DISTRIBUTION OF SINGLE DOMAIN POWDERS. C.E.Johnson,Jr and W.F.Brown,Jr.
J. appl. Phys., Vol. 29, No. 3, 313-14 (March, 1958).

By demagnetizing a magnetic powder specimen with diminishing alternating fields of various initial amplitudes and by interpreting the results with the Stoner–Wohlfarth model, one can obtain information about the shape distribution of the particles. This was done with powders of acicular γ-ferric oxide at various temperatures; the temperature variation of the results gave information about the size distribution. The sample was first magnetized to saturation; the diminishing a.c. field then applied and the remanence measured. Since the particles are not aligned along the applied field, it is necessary to get the equivalent magnetization curve for an aligned sample by operating on the data mathematically. The results indicate that only a small volume fraction of the γ-ferric oxide particles are small enough to be a paramagnetic. There is a relatively large volume fraction of particles with nearly zero critical field. It is thought that this is caused by particles which change their magnetization by a mechanism different from the Stoner–Wohlfarth uniform rotation. On a volume basis, the shape distribution curves peak at a length-to-diameter ratio of about 1.6 : 1, which gives a coercive force of 300 oersted. The coercive force agrees very well with measured values. The length-to-diameter ratio does not agree with electron microscopic observations, which give a mean of about 5 : 1. A.

538.221

8889. MAGNETIC MEASUREMENTS ON SOME PRECIPITATING SYSTEMS. A.E.Berkowitz and P.J.Flanders.
J. appl. Phys., Vol. 29, No. 3, 314-16 (March, 1958).

In the systems Au–Ni and β-brass–Fe, ferromagnetic precipitate particles develop in a non-magnetic matrix. Single crystal samples of these alloys were examined by measuring saturation magnetization, torque curves, rotational hysteresis, and remanence. The data on the Au–Ni system was analysed to infer particle anisotropy distributions, orientation of the "easy" axes of the particles, and other features of the precipitate particle system. Electron micrographs of the precipitate particles are in general agreement with this analysis. The measurements on the β-brass–Fe system indicated that the precipitate particles were single crystals with the same crystal habit as the matrix, and were elongated in the $\langle 111 \rangle$ directions. The temperature dependence of the torque curves was identified with the temperature dependence of shape and magneto-crystalline anisotropy. A.

538.221

8890. PRECIPITATION AND MAGNETIC ANNEALING IN A COPPER–COBALT ALLOY. J.J.Becker.
J. appl. Phys., Vol. 29, No. 3, 317-18 (March, 1958).

In an alloy containing 2% cobalt, balance copper, it is possible to quench a nonmagnetic solid solution from 1000°C and then produce a ferromagnetic precipitate in a nonmagnetic matrix by ageing at several hundred degrees. The magnetic properties of this precipitate can be correlated with the size and shape of the precipitate particles. Considerable information about the precipitation process can be obtained in this way. In these experiments, saturation magnetization, torque, rotational hysteresis, remanence, coercive force for zero magnetization, and coercive force for zero remanence (which behaves in a surprising fashion) were observed during the course of ageing. In particular, the effect of a field during ageing in producing magnetic anisotropy ("magnetic annealing") was studied and is shown to occur entirely during the growth of the particles, after the precipitation is complete. The precipitation process is viewed as one in which the particles as they grow are first superparamagnetic, then stable single domains, and finally multidomain. This point of view is consistent with all of the varied phenomena observed. A.

538.221

8891. FERROMAGNETIC RESONANCE AND NONLINEAR EFFECTS IN YTTRIUM IRON GARNET.
R.C.LeCraw, E.G.Spencer and C.S.Porter.
J. appl. Phys., Vol. 29, No. 3, 326-7 (March, 1958).

A study of ferromagnetic resonance at 9300 Mc/s and 3000 Mc/s in single crystals of yttrium iron garnet is described. Cavity perturbation techniques were used with polished spherical samples 9 to 11 mils in diameter. The line widths along the hard axis [100] were found to be 2.3 and 5.7 Oe, respectively, at 9300 Mc/s and 3000 Mc/s. It is believed the 2.3 Oe is the narrowest resonance line yet observed on spheres of ferromagnetic material at room temperature. Because of the narrow line-widths, the nonlinear behaviour of these crystals is of particular interest. At 9300 Mc/s the r.f. field, h_{crit}, for saturation of the main resonance line is 46 millioersted. Using Suhl's spin-wave theory of nonlinear effects in ferromagnets, the 46 millioersted (associated with a z-directed spin-wave) predicts a spin–lattice relaxation time T_1 of 7.4×10^{-8} sec, in good agreement with the 7.0×10^{-8} sec measured by other independent methods. This T_1 then predicts an "intrinsic" line width of 1.54 oersted. Thus the observed line-width of these crystals at 9300 Mc/s is within a factor 1.5 of its theoretical limiting value. At 3000 Mc/s, where the subsidiary resonance coincides with the main resonance, h_{crit} is 5.0 millioersted (associated with spin-waves not z-directed). As the temperature is increased toward 340°K, an interesting effect is observed. The h_{crit} rises quite abruptly; in fact it changes by 10.5 dB between 335°K and 340°K. This and other observations are compared with Suhl's nonlinear theory with good results. A.

538.221 : 539.4.016

8892. MAGNETIC ANISOTROPY INDUCED BY MAGNETIC ANNEALING AND BY COLD WORKING OF Ni_3Fe CRYSTAL.
S.Chikazumi.
J. appl. Phys., Vol. 29, No. 3, 346-50 (March, 1958).

After a brief report on the experiments which have been made on magnetic annealing, recent investigations on the magnetic anisotropy which is induced by cold rolling are described. The local and the average anisotropy induced by rolling was observed by means of domain pattern and torque measurement for (110)[001], (001)[110], (001)[100] rolling of single crystals and rolling of polycrystals. It was shown that the anisotropy for individual cases was well explained by assuming the "slip-induced directional order". Two types of the anisotropy, i.e. long-range order (fine slip) type and short-range order (coarse slip) type, were calculated. Dependence on the degree of order and its difference between single and polycrystals are also discussed. A.

538.221

8893. EFFECTS OF COMPOSITION AND PROCESSING VARIABLES ON THE MAGNETIC PROPERTIES OF THE 50% NICKEL–IRON ALLOY. M.J.Savitski.
J. appl. Phys., Vol. 29, No. 3, 353-5 (March, 1958).

In a factorial experiment, a study was made of the effects of small amounts of alloying elements and processing variables on the magnetic properties of the 50% nickel–iron alloy. The composition variables were: three levels of manganese, two of silicon, two of sulphur, and two of oxygen. The processing variables were: hot rolling at two temperature levels, annealing or not annealing after hot rolling, and final annealing at six temperature levels. The ingots were processed to tape from which toroidal cores were made. The results of magnetic tests made with a constant current, flux-reset core tester indicate that certain elements need to be added to the melt to produce a grain-oriented alloy with satisfactory magnetic properties, and that the processing must be compatible with the additions made. The binary manganese–oxygen addition was most beneficial. In general, hot rolling at a high temperature level was beneficial, and annealing after hot rolling was detrimental to the magnetic performance. A.

538.221 : 621.318.13

8894. MAGNETIC PROPERTIES OF CUBE TEXTURED SILICON–IRON MAGNETIC SHEET. J.L.Walter, W.R.Hibbard, H.C.Fiedler, H.E.Grenoble, R.H.Pry and P.G.Frischmann.
J. appl. Phys., Vol. 29, No. 3, 363-5 (March, 1958).

The magnitude of the cube texture as determined by torque magnetometer tests is of the order of 90% or greater when compared to a single crystal with a (100) [001] orientation. The magnitude of the texture was confirmed by X-ray diffraction pole figures. Static d.c. magnetic tests and 60 c/s a.c. power loss tests made on single strip samples taken both parallel to the rolling direction and

at right angles to the rolling direction indicate nearly equal magnetic properties in both directions of the sheet. These properties are equivalent to the magnetic properties measured in the single good direction of the grain oriented transformer material. Finally, two transformers were made: one using laminations of the cube textured silicon iron, the other of the grain oriented material. It was found that transformer made of the cube textured material produced significantly lower energy losses at all inductions and at 17 000 G the losses were approximately 60% of the losses produced by the grain oriented transformer. Similarly the current required to produce 17 000 G in the cube textured transformer was again about half that required to excite the grain oriented transformer to the same induction. A.

538.221

8895. CUBE TEXTURE IN BODY CENTERED MAGNETIC ALLOYS. G.Wiener, P.A.Albert, R.H.Trapp and M.F.Littmann.
J. appl. Phys., Vol. 29, No. 3, 366-7 (March, 1958).

Cube oriented, (100) [001], iron silicon alloys were prepared in thickness ranging from 0.8 mil to 11.0 mils. Both a.c. and d.c. magnetic properties are given for the alloys. The data show that comparable properties to commercial singly oriented steel of the (110) [001] texture are obtained both parallel and perpendicular to the rolling direction. The magnetic properties are sensitive to both the amount of cube oriented grains and the distribution of the directions about the rolling direction of the sheet. A.

538.221

8896. LOW RESIDUAL INDUCTION IN HIGH-ALUMINUM IRON ALLOYS. D.Pavlovic and K.Foster.
J. appl. Phys., Vol. 29, No. 3, 368-9 (March, 1958).

Low values of residual induction were observed for different heat treatments in 0.007 and 0.014 in. thick sheets of aluminium–iron alloys containing 10 to 16 weight % aluminium. For these materials the ratio of residual induction (B_r) to induction at 100 oersted (B_{100}) gave values of 0.05 to 0.1. These low residual induction values apparently occur at compositions having zero crystal anisotropy for both furnace-cooled and water-quenched alloys. Domain patterns were observed in these low B_r alloys but, in general, no evidence of domain patterns was observed in the same alloys when the B_r/B_{100} ratio was increased, through suitable heat treatment, to a value greater than about 0.2. The fairly high magnetostriction of the alloys around the Fe_3Al composition and the stress produced by cooling through differently ordered regions may be considered to produce a high "stress anisotropy" resulting in pronounced domain patterns and perhaps also to contribute to the lowering of the residual induction of these alloys. A.

538.221 : 539.379

8897. EFFECT OF ELASTIC BENDING ON MAGNETIC PROPERTIES OF ORIENTED SILICON IRON. R.W.Cole.
J. appl. Phys., Vol. 29, No. 3, 370-1 (March, 1958).

To determine the a.c. and d.c. magnetic properties are affected by elastic strain, the magnetic properties in the rolling direction of Epstein strips of elastically bent grain-oriented 3% silicon iron were measured in an Epstein frame and in a Carr single-strip permeameter. As the degree of bending becomes more pronounced, the coercive force and the a.c. core loss increase and the permeability decreases. The domain theory gives a rather simple approximate interpretation of the permeability data for magnetic intensities between one and ten oersted. A.

538.221

8898. PREFERENTIAL VOLATILIZATION OF CATIONS FROM FERRITES DURING SINTERING. J.M.Brownlow.
J. appl. Phys., Vol. 29, No. 3, 373-5 (March, 1958).

The abnormal plots of reduced magnetization v. temperature for ferrites containing zinc are found to be associated with a concentration gradient in zinc that is generated by the preferential loss of zinc during sintering. The variation of the gradient in samples of zinc–iron spinels is correlated with sintering and annealing treatment and with sample dimensions. A.

538.221

8899. SOME FERRIMAGNETIC PROPERTIES OF THE SYSTEM $Li_xNi_{1-x}O$.
J.B.Goodenough, D.G.Wickham and W.J.Croft.
J. appl. Phys., Vol. 29, No. 3, 382-3 (March, 1958).

Crystallographic and magnetic measurements of the system $Li^+_xNi^{++}_{1-2x}Ni^{+++}_xO$ for the entire range $0 \leq x < 0.5$ are reported. For values of $x \leq 0.3$, the lattice appears to be antiferromagnetic and is cubic above the Curie temperature. For the range of composition $0.3 < x < 0.5$, the lattice if rhombohedral and apparently ferrimagnetic, a maximum magnetic moment per gram of 31 c.g.s. cm^3/g being observed at $x = 0.46$. A maximum ferrimagnetic Curie temperature of 241°K was observed for the composition $x = 0.41$. These properties are interpreted in terms of a partial ordering of Li and Ni ions into alternate sets of (111) planes which couple antiparallel to one another, the moments within any set being either ferromagnetically coupled or paramagnetic, depending upon the number of nonmagnetic near neighbours in the neighbouring planes. A.

538.221

8900. EFFECT OF THERMAL HISTORY ON THE ANTIFERROMAGNETIC TRANSITION IN ZINC FERRITE.
D.M.Grimes and E.F.Westrum, Jr.
J. appl. Phys., Vol. 29, No. 3, 384-5 (March, 1958).

Quenched zinc ferrite is ferrimagnetic, annealed ferrite paramagnetic at 300°K. Although annealed zinc ferrite has a lambda type heat capacity transition at about 9.5°K, quenched zinc ferrite retains only elementary vestigia of this transition. A similar effect exists in $Li_{0.05}Zn_{0.90}Fe_{2.05}O_4$ in which the transition temperature is slightly lowered relative to that of zinc ferrite. This temperature shift does not appear to exist for $Ni_{0.1}Zn_{0.9}Fe_2O_4$. The magnetic entropy at 300°K is essentially unaltered by lithium substitution or thermal history. A.

538.221

8901. MAGNETIC GERMANATES ISOSTRUCTURAL WITH GARNET. A.Tauber, E.Banks and H.H.Kedesdy.
J. appl. Phys., Vol. 29, No. 3, 385-7 (March, 1958).

In order to study the magnetic interaction between the eightfold and the combined six and fourfold sites in the garnet structure, several germanate garnets were synthesized. If no magnetic cation was present in the fourfold site no spontaneous magnetization was found in the temperature range 90° to 500°K. A partial substitution of the nonmagnetic cation in the fourfold site by magnetic cations, however, leads to a spontaneous magnetization. A.

538.221 : 621.317.4

8902. MEASUREMENT OF THE PROPERTIES OF VARIOUS FERRITES USED IN MAGNETICALLY TUNED RESONANT CIRCUITS IN THE 2.5 – 45 Mc/SEC REGION.
P.P.Lombardini, R.F.Schwartz and R.J.Doviak.
J. appl. Phys., Vol. 29, No. 3, 395-6 (March, 1958).

An investigation was conducted directed toward securing data for choosing the best ferrite to be used in the Penn-Princeton 3 BeV high intensity proton synchotron being built at Princeton University. The ferrite samples tested were from American and European manufacturers and were in the form of small rings 2 in. or less in diameter. Measurements were required of μ and Q under varying magnetic bias, at various r.f. flux levels, in the band frequencies 2.5 to 45 Mc/s. At the beginning of this research no clear method existed for a proper choice of ferrite, and generally speaking the manufacturers' data were inadequate. Therefore a novel technique of measurement was devised, and an effort was made to establish a minimum number of parameters for defining ferrite properties for this application. A description of the techniques used is given, with a resume of the results obtained. A.

538.221

8903. SOME ASPECTS OF TEMPERING 3¼% SILICON STEEL AS FOLLOWED BY TIME DECAY OF PERMEABILITY.
E.S.Anolick and J.Singer.
J. appl. Phys., Vol. 29, No. 3, 412-13 (March, 1958).

The time decay of permeability was employed in the study of the distribution of interstitials (C,N) in 3¼% Si steel. In following the 150°C tempering of slowly cooled samples, a reversion phenomenon was noted. A method is discussed for obtaining the solubility of carbon over a limited range of temperature, with some preliminary results included. A.

538.221

8904. SPIN–LATTICE RELAXATION TIME IN YTTRIUM IRON GARNET. R.T.Farrar.
J. appl. Phys., Vol. 29, No. 3, 425-6 (March, 1958).

The spin–lattice relaxation time in yttrium iron garnet (YIG) was measured by a pulsed ferromagnetic resonance method similar to that of Bloembergen and Wang and Damon, in which the z component of magnetization is directly observed. A microwave pulse with 2×10^{-8} sec rise and decay time, 5×10^{-7} sec long, and 2 W peak power is applied to a TE_{102} rectangular cavity operating at 9300 Mc/s. The z component of magnetization M_z changes at the beginning and at the end of the r.f. pulse. The time of decay of the

changing M_Z signal at the trailing edge of the pulse (at which time the applied r.f. field is zero) is a measure of the spin—lattice relaxation time. A spherical sample of YIG, 0.03 in. diam, is placed in a quartz tube, 0.05 in. o.d., about which a five turn coil of wire is wound. The coil with sample is inserted in the centre of the cavity with the axis of the coil in the z direction. At this position, the r.f. magnetic field is maximum and the electric field is a minimum. The presence of the coil does not measurably change the properties of the cavity. The voltage induced in the coil is proportional to the change in M_Z and is observed on a high-speed oscilloscope. The time constant of the equipment is approximately that of the exciting pulse. Thus the spin—lattice relaxation time can be accurately determined directly if it is appreciably larger than this value. The ferromagnetic resonance line width is 2.3 oersted and the measured spin—lattice relaxation time is 7×10^{-8} sec. A.

538.221

8905. EFFECT OF CATION VACANCIES ON THE MAGNETIC ANNEALING OF COBALT-SUBSTITUTED MAGNETITE.
L.R.Bickford,Jr, J.M.Brownlow and R.F.Penoyer.
J. appl. Phys., Vol. 29, No. 3, 441-2 (March, 1958).

Five crystals of nominal composition $Co_{0.1}Fe_{2.9}O_4$, grown from the melt under different partial pressures of oxygen, were subjected to magnetic annealing at 100°C. The relaxation time characterizing the annealing process is shown to increase from several minutes for crystals known to contain cation vacancies to a value too large to be determined for a crystal essentially stoichiometric with respect to oxygen content. The observed changes in relaxation time and magnitude of the anneal-induced anisotropy are interpreted as the effect of cation vacancies on the ease of movement of cobalt ions between equivalent cation sites during the annealing process. A.

538.221

8906. RELATIONSHIP BETWEEN SINGLE CRYSTAL AND EFFECTIVE POLYCRYSTALLINE ANISOTROPY CONSTANTS IN FERRITES. C.J.Kriessman, S.E.Harrison and H.S.Belson.
J. appl. Phys., Vol. 29, No. 3, 452-3 (March, 1958).

In polycrystalline ferrites the natural spin resonance of electrons in the effective resonance field, detected by initial permeability measurements, allows the determination of an effective anisotropy constant, K_e. It is shown from measurements of K_1 on single crystals by microwave techniques that $K_e = 2K_1$. This result is based on work on $Mn_{1+x}Fe_{2-x}O_4$, $NiFe_2O_4$, and $MgFe_2O_4$. A.

538.221

8907. EFFECT OF COBALT ON THE RELAXATION FREQUENCY OF NICKEL ZINC FERRITE.
F.J.Schnettler and F.R.Monforte.
J. appl. Phys., Vol. 29, No. 3, 477-8 (March, 1958).

The complex permeabilities of a number of Ni-Zn-Co ferrites were measured as a function of frequency from 0.1 to 250 Mc/s. These ferrites were prepared under identical conditions from reagent grade chemicals. Their compositions differed in the relative amounts of cobalt, nickel and zinc they contained, the amount of iron being held constant. A number of specimens of each composition were prepared at different firing temperatures, so as to include a variation in the degree of reaction. An analysis of the data was made in which the initial permeability and relaxation frequency were correlated with certain composition and structure variables. They include the quantity of cobalt, the nickel—zinc ratio, the firing temperature, and the amount of shrinkage which occurred during firing. It was found that these variables would account for 88% of the variations of the initial permeability and 70% of the variations of the relaxation frequency. A further result of the analysis defines the conditions for obtaining maximum quality ($\mu_o f_o$) at a given value of initial permeability. A.

538.221

8908. MAGNETIC FLUCTUATIONS IN MOLYBDENUM PERMALLOY. J.J.Brophy.
J. appl. Phys., Vol. 29, No. 3, 483-4 (March, 1958).

Considerations of generalized noise and magnetic viscosity suggest the existence of magnetic fluctuations in ferromagnets. Magnetic fluctuations in molybdenum permalloy tape ring cores were detected by observing noise voltages at the terminals of a coil wound on the sample. For thin tape cores and at low frequencies, the observed magnetic noise spectrum is in excess of Nyquist noise and is characteristic of a slow relaxation phenomenon with an activation energy of 0.04 eV. For thick tape cores and at high frequencies, core losses yield noise voltages in agreement with Nyquist's law and provide a means of studying ferromagnetic loss with magnetic excitation. A.

538.221

8909. TRANSITIONS FROM FERROMAGNETISM TO ANTIFERROMAGNETISM IN IRON ALUMINUM ALLOYS.
H. Sato and A.Arrott.
J. appl. Phys., Vol. 29, No. 1, 515-17 (March, 1958).

A study of magnetic isotherms over the range of compositions from pure Fe to 40 atomic % Al in Fe and over temperatures from 4°K to 300°K, produced strong evidence for the existence of superexchange interactions between iron atoms separated by aluminium atoms. The iron-rich alloys show ferromagnetism in the usual way, but for concentrations approaching 40 atomic % Al the alloys behave as antiferromagnetic with Néel points near liquid-hydrogen temperatures. There is a transition range of composition in which the stable state just below the Curie temperature is ferromagnetic but at low temperatures is antiferromagnetic. The large changes in magnetic properties occur for the ordered structures and in composition ranges where the number of nearest neighbour iron—iron interactions is changing rapidly with composition, but where the number of next nearest neighbour iron—iron interactions remains practically constant. These considerations lead to a model where only the nearest neighbour direct positive exchange interactions between iron atoms, and indirect negative exchange interactions between iron atoms separated by an aluminium atom are taken into account. The treatment by a Bragg—Williams type calculation leads to a qualitative understanding of the observed magnetic effects in the iron—aluminium system, including the differences between the disordered state and the two types of ordered states. The model also leads to a reinterpretation of neutron diffraction data. A.

538.221

8910. UNUSUAL MAGNETIC BEHAVIOR OF DISORDERED Ni_3Mn. J.S.Kouvel, C.D.Graham,Jr and J.J.Becker.
J. appl. Phys., Vol. 29, No. 3, 518-19 (March, 1958).

Measurements were made of the magnetization of disordered Ni_3Mn alloy for various fields between 945 and 7550 Oe and at many temperatures between 1.5 and 300°K. The magnetization v. temperature curve for any given field is found to have a pronounced maximum at about 25°K and a long concave-upward section extending from about 140°K to temperatures above 300°K. By means of a new method of analysis, the Curie point is deduced to be 132°K. An abnormally large induced magnetization, greatest at about 50°K, is also found. All the experimental results are consistent with the occurrence of a ferrimagnetic—ferromagnetic transition at low temperatures. A.

538.221

8911. MAGNETIC MOMENTS AND APPARENT MOLECULAR FIELDS IN SOME RARE EARTH METALS AND COMPOUNDS.
W.E.Henry.
J. appl. Phys., Vol. 29, No. 3, 524-5 (March, 1958).

A study was made of the absolute magnetization of some rare-earth metals (gadolinium and cerium) and some compounds (ytterbium oxide, neodymium oxide, erbium oxide and yttrium iron garnet) as a function of magnetic fields up to 60 000 gauss and temperature down to 1.3°K. The saturation magnetization of ferromagnetic gadolinium is 7.05 ± 0.10 Bohr magneton per atom of gadolinium and its molecular field is 1.3 megagauss. The average magnetization of cerium is only 0.17 Bohr magneton per atom of cerium even at 1.3°K and 60 000 gauss. It is ferrimagnetic with an estimated antiferromagnetic molecular field of one-half megagauss. Ytterbium sesquioxide has an antiferromagnetic molecular field of about 35 000 gauss and becomes antiferromagnetic at about 3°K in zero field. Yttrium iron garnet was studied and the saturation magnetization was determined at 100°K and in the helium range. The saturation magnetization is 0.83 at 1.3°K as compared with 1.25 Bohr magnetons per atom of iron in gamma iron (III) oxide studied previously. A ballistic method was used for measuring the magnetic moment and the calibration was made using metallic iron. A.

538.221 : 539.27 : 621.318.1

8912. ELECTRON MIRROR MICROSCOPY OF [MAGNETIC] PATTERNS RECORDED ON MAGNETIC TAPE. L.Mayer.
J. appl. Phys., Vol. 29, No. 4, 658-60 (April, 1958).

Experimental evidence is presented demonstrating that electron mirror microscopy can provide micrographs of patterns written on magnetic tapes. Successful utilization of the principle of electron mirror microscopy for depiction of magnetic patterns on magnetic tapes may have general significance with respect to magnetic

memory systems. The high resolving power of the electron mirror microscope and the fact that it is an electronic device suggests further experimentation aimed at an all-electronic, fast-reading magnetic memory system with large storage capacity. A.

538.221 : 548.736

8913. MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF SUBSTITUTED YTTRIUM–IRON GARNET, $3Y_2O_3 \cdot xM_2O_3 \cdot (5-x)Fe_2O_3$. M.A.Gilleo and S.Geller.
Phys. Rev., Vol. 110, No. 1, 73-8 (April 1, 1958).

A solid solution of yttrium–iron garnet with yttrium–gallium or yttrium–aluminium garnet is formed over the entire range of composition; the lattice constant variation is nearly linear. The trivalent ions, Sc^{3+}, In^{3+}, and Cr^{3+}, may be substituted for Fe^{3+} to a limited extent. Substitution proceeds on a steric basis for non-magnetic ions: those smaller than Fe^{3+}, namely Al^{3+} and Ga^{3+}, preferentially occupy the smaller, tetrahedrally coordinated sites, 24(d); larger ions, In^{3+} and Sc^{3+}, preferentially occupy larger, octahedrally coordinated sites, 16(a). The Cr^{3+} ion, though smaller than Fe^{3+}, preferentially occupies the octahedral site, presumably because of its electronic configuration. The magnetic moment initially rises with octahedral substitution of nonmagnetic ions and falls with tetrahedral substitution because the moment corresponds to the difference in the moments of the Fe^{3+} ions in the two octahedral sites and the three tetrahedral sites per formula unit, $Y_3Fe_2(FeO_4)_3$. The Curie temperature is decreased by the substitution of nonmagnetic ions for iron on account of the decrease in the number of $Fe^{3+}-O^{2-}-Fe^{3+}$ interactions. A.

538.221 : 548.74

8914. NEUTRON DIFFRACTION INVESTIGATION OF THE 119°K TRANSITION IN MAGNETITE. W.C.Hamilton.
Phys. Rev., Vol. 110, No. 5, 1050-7 (June 1, 1958).

Neutron diffraction measurements on synthetic single crystals of magnetite confirm the orthorhombic ordering scheme proposed by Verwey and coworkers to explain the changes in physical properties which magnetite undergoes when cooled below 119° K. A magnetic field suitably applied during cooling prevents the multiple twinning which occurs in the absence of a field and allows one to make the following deductions: The spins of all magnetic ions align themselves parallel to the cubic [001] direction nearest the direction of the external field. The face diagonals of the cube orthogonal to this c axis become the orthorhombic a and b axes. If these are labeled such that a is magnetically harder than b, the ferric ions in octahedral sites lie in rows parallel to a and the ferrous ions in rows parallel to b. Although the average oxygen position is unchanged, there are presumably shifts in the four oxygen parameters which compensate for the effect of the ordering on the ionic sizes at the various sites. In attempting to reproduce the results on natural crystals, which had a transition temperature some five to ten degrees lower, it was found impossible to remove the [a,b] twinning by use of a magnetic field; furthermore, failure to observe an (002) reflection would seem to indicate that the twinning persists on a micro basis, that is, that there is only short-range order. A least-squares fit was made to the intensities of the cubic phase at 296° K; a value of $u = 0.2548 \pm 0.0002$ was obtained for the oxygen parameter in the spinel structure. The severe primary and secondary extinction encountered was satisfactorily accounted for by methods previously described by the author. A.

538.221

8915. FERROMAGNETIC RESONANCE LINE WIDTH IN YTTRIUM IRON GARNET SINGLE CRYSTALS.
R.C.LeCraw, E.G.Spencer and C.S.Porter.
Phys. Rev., Vol. 110, No. 6, 1311-13 (June 15, 1958).

A study of ferromagnetic resonance line width in polished, single-crystal spheres of yttrium iron garnet is described. Waveguide cavity perturbation techniques are used with samples 0.013 in. to 0.020 in. in diameter. An extremely narrow line width of 520 millioersteds (the full width) is observed at 9300 Mc/s along the hard axis [100]. It is believed this is the narrowest resonance line yet reported on ferromagnetic materials. The line width is shown to be strongly influenced by the sample surface, with the line narrowing by over a factor of twenty as the polishing proceeds. The line width at 3000 Mc/s on the same sample is 530 millioersteds. The approximate invariance of the line width for more than a three-to-one change in frequency is compared with the predictions of some recent theories of ferromagnetic resonance line width. The invariance of line width with frequency is also used to conclude that $\lambda\omega$ and T_2 in the Landau–Lifshits and Bloch–Bloembergen equations of motion, respectively, are approximately constant over this frequency range. A.

538.221

8916. NATURAL FERROMAGNETIC RESONANCE IN NICKEL, MAGNESIUM AND COBALT FERRITES.
T.M.Perekalina and A.A.Askochenskiĭ.
Zh. tekh. Fiz., Vol. 28, No. 3, 511-17 (1958). In Russian.

The complex magnetic permeability spectra of sintered Ni, Mg and Co ferrites were investigated in a wide frequency range (0.45-20 000 Mc/s), embracing both the rotation and the displacement of the magnetic domains boundaries processes. The experimental results, given in the form of graphs showing the variation of the real and imaginary parts of permeability with frequency, are correlated with the theoretical curves plotted from the formulae derived by Kittel (Abstr. 6315/1951) for μ_r (permeability due to the rotational processes) and μ_d (permeability associated with the boundary displacement). Although no definite conclusions were reached regarding the low frequency range, the validity of the Landau and Lifshits theory (Abstr.5226/1935) in the form given by Kittel was confirmed. 14 ref. M.H.Sloboda

538.221 : 539.219 : 621.318.22

PHASE ANALYSIS OF ALNICO V. See Abstr. 9139

538.221 : 539.27

ELECTRON MICROSCOPICAL STUDY OF THE METALLOGRAPHIC STRUCTURE OF TWO ALLOYS FOR PERMANENT MAGNETS. See Abstr. 9149

538.221 : 545.8

MAGNETIC ANALYSIS OF THE URANIUM–OXYGEN SYSTEM. See Abstr. 9175

538.221.08

8917. THE DETERMINATION OF THE PERMEABILITY OF FERROMAGNETIC MATERIALS FROM THE THERMAL NOISE-VOLTAGE OF A COIL. W.Nonnenmacher and L.Schweizer.
Z. angew. Phys., Vol. 9, No. 5, 239-45 (May, 1957). In German.

The inductance and effective resistance of a coil containing a ferromagnetic specimen are deduced from the noise spectrum of a resonant circuit which includes the coil. The components of the complex permeability, at the low magnetizing fields corresponding to the thermal-noise currents in the coil, are calculated from the results, and show good agreement with values obtained by extrapolating to zero measuring field the results of bridge measurements on the same specimens. The noise spectrum method is also compared with the bridge method for different intensities of magnetization, with good agreement. A.J.Manuel

538.221.08 : 539.27

USE OF ELECTRON DIFFRACTION FOR THE STUDY OF FERROMAGNETIC MATERIALS. See Abstr.8477

538.222

8918. MAGNETIC SUSCEPTIBILITY OF NEUTRON-IRRADIATED QUARTZ. D.K.Stevens, W.J.Sturm and R.H.Silsbee.
J. appl. Phys., Vol. 29, No. 1, 66-8 (Jan., 1958).

Measurements are reported of the susceptibility as a function of irradiation time. The results are interpreted in terms of the density of centres produced by the irradiation, and are compared with optical and X-ray studies of neutron damaged quartz. A.

538.222 : 536.48

8919. MAGNETIC SUSCEPTIBILITY OF FERROUS AMMONIUM TUTTON SALT AT LIQUID HELIUM TEMPERATURES.
J.T.Richardson and R.C.Sapp.
J. chem. Phys., Vol. 29, No. 2, 337-9 (Aug., 1958).

The magnetic susceptibility of ferrous ammonium sulphate hexahydrate was measured between 0.95 and 4.2° K by both the Faraday and the ballistic mutual inductance bridge methods. At 4.2° K the susceptibility is $(1.45 \pm 0.05) \times 10^{-3}$ e.m.u./g, close to the value given by the high temperature Curie–Weiss law, $9.71 \times 10^{-3}/(T+3.2)$. Below 2° K the susceptibility is constant at $(1.85 \pm 0.05) \times 10^{-3}$ e.m.u./g. The results are shown to be compatible with available specific heat data in the low temperature region, provided that the lowest level is taken to be a singlet and the constant susceptibility is ascribed to temperature-independent paramagnetism of the lowest level. A.

538.222 : 538.247

8920. RELAXATION EFFECTS IN THE MAGNETIZATION OF CHROMIC METHYLAMINE ALUM BELOW ITS NÉEL POINT.
C.W.Dempesy and R.C.Sapp.
Phys. Rev., Vol. 110, No. 2, 332-6 (April 15, 1958).

A moving-coil apparatus is described which makes possible the measurement of static susceptibilities of paramagnetic salts cooled by adiabatic demagnetization to temperatures below 1° K. The sample studied was a 2:1 ellipsoid of revolution, with major

dimension along a cubic axis, shaped from a single crystal of chromic methylamine alum. In contrast to data obtained by the customary mutual inductance bridge method with ballistic galvanometer detection under comparable conditions, the new technique made possible the direct study of a long relaxation time in the magnetizing process, which was observed whenever the crystal was cooled below its Néel point. An additional sharp peak in the susceptibility as a function of entropy was also found in this region. It is pointed out that the theory of magnetic ordering in the chromic alums can successfully account for the general dependence of susceptibility on entropy. A.

538.222

8921. PARAMAGNETIC RESONANCE IN NEODYMIUM NITRATE. T.I.Sanadze.
Zh. éksper. teor. Fiz., Vol. 33, No. 4(10), 1042-3 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6, No. 4, 801-3 (April, 1958).

Measurements were made at 3.2 cm of the spectrum of neodymium nitrate diluted with 1 part in 200 of lanthanum. The spectrum consists of one intense line and two groups of eight resulting from the hyperfine structure of the odd isotopes 143 and 145 (I = 7/2). The line width was due to spin-lattice relaxation. Values were derived for the hyperfine splitting constants which were approximately proportional to the g-values. D.J.Oliver

538.222

8922. MAGNETIC RESONANCE OF NUCLEI OF PARAMAGNETIC ATOMS. K.A.Valiev.
Zh. éksper. teor. Fiz., Vol. 33, No. 4(10), 1045-7 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6, No. 4, 804-5 (April, 1958).

Theoretical calculations show that nuclear resonance of paramagnetic ions may be observed between 10^8-10^9 c/s for fields ~ 10^3 Oe. In dilute crystals the line width will be determined by spin lattice relaxation. It is concluded that the Cr resonance will be observable in the chrome alums at liquid-air temperatures but in vanadium salts only at lower temperatures. The technique can be used to measure dipole and quadrupole coupling constants and spin lattice relaxation times. D.J.Oliver

538.222 : 537.312.62

PARAMAGNETIC EFFECT IN SUPERCONDUCTORS.
See Abstr. 8784-6

538.24.08 : 621.317.42

8923. METHOD FOR MEASURING SATURATION MAGNETIZATION IN RING SAMPLES. C.D.Graham, Jr.
J. appl. Phys., Vol. 29, No. 1, 68-70 (Jan., 1958).

This method permits the measurement of saturation and of low-field magnetic properties in the same sample, and consists of saturating the sample in a strong field directed perpendicular to the plane of the ring, changing the direction of the magnetization slightly with a circumferential field, and measuring the resultant flux change in the ring. The procedure also gives an accurate value for the cross-section area of the secondary winding on the specimen. A.

538.245 : 538.652

8924. METHOD FOR MEASURING MAGNETOSTRICTION CORRECTED FOR INITIAL DOMAIN DISTRIBUTION AND ITS APPLICATION TO NICKEL AND IRON. H.E.Stauss.
J. appl. Phys., Vol. 29, No. 2, 182-4 (Feb., 1958).

A method was developed for the measurement of magnetostrictive strain that overcomes the effect of initial domain distribution in isotropic materials. A cubic specimen is used, placed between two iron rods of the same cross-section. The combination is put along the common axis of two like solenoids connected in series. Strain is measured with a resistance strain-gauge, first parallel to the magnetic field, and then normal to the field after the specimen has been rotated through 90°. At saturation the algebraic difference gives 3/2 of the saturation magnetostriction. Use of the difference eliminates or reduces a number of experimental errors in addition to that arising from nonrandomness of initial domain distribution. The method was applied to grade A nickel and armco iron. A.

538.245

8925. RELATION BETWEEN COLLOID PATTERN AND PERMANENT MAGNET PRECIPITATE DURING THE MAGNETIZATION REVERSAL IN ALNICO V. K.J.Kronenberg and R.K.Tenzer.
J. appl. Phys., Vol. 29, No. 3, 299-301 (March, 1958).

Improved electron microscope observation technique confirmed some of the basic assumptions on the structure of Alnico V. The permanent magnet precipitate was investigated at various states of its growth starting from nucleation. Pictures with details smaller than 20 A reveal the completely developed structure of Alnico V which differs somewhat from former descriptions. It can be recognized clearly that the precipitated particles have grown together to a continuous anisotropic network subdividing the matrix. Colloid patterns on these surfaces were observed with electron microscope. During the reversal of magnetization, an anisotropic structure in the colloid-covered areas of the pattern could be distinguished. The colloid particles align themselves, preferring one of the two faces of the precipitated structure. This is most pronounced in the steep part of the demagnetization curve. It can be observed as soon as the colloid starts to form patterns. The necessary surveying of magnet surfaces was possible by preparing very thin oxide replicas with a simple technique that eliminated the former "floating" method. Replicas were stripped from the surface which preserved the orientation without destroying the surface of the magnet. A.

538.245

8926. EFFECTS OF MAGNETIC FIELDS UPON ANISOTROPIC IRON CRYSTALS. J.H.L.Watson, A.Arrott and M.W.Freeman.
J. appl. Phys., Vol. 29, No. 3, 306-8 (March, 1958).

Problems inherent to magnetic alignment of alpha iron crystals are discussed and explained by electron microscopic observation of the behaviour of the single domain crystals under the effect of magnetic fields. With these specimens, which possess a fraction of magnetically unfavourable dendrites, intrinsic coercive forces of over 1700 oersteds have been measured without alignment. A.

538.245

8927. MAGNETIZATION REVERSAL BY ROTATION.
P.R.Gillette and K.Oshima.
J. appl. Phys., Vol. 29, No. 3, 529-3 (March, 1958).

The mechanism of magnetization reversal by simple rotation has been discussed by many authors, but a completely general analysis (applicable to a single-domain ferromagnetic body of any type of anisotropy, with an applied field in an arbitrary direction) has not been given. The purpose of this paper is to present such an analysis. General differential equations are derived which can be used to describe the rotation process in any body for which demagnetization and anisotropy factors can be written. These equations are then applied to a sphere, a cylinder, and a thin sheet. Both uniaxial and cubic anisotropy are considered for the sphere and cylinder; only uniaxial anisotropy (the kind observed in deposited films) is considered for the thin sheet. The resulting differential equations can be solved numerically to obtain output voltages, switching times, and switching constants. A.

538.245 : 548.524

8928. GROWTH OF MnBi CRYSTALS AND EVIDENCE FOR SUBGRAINS FROM DOMAIN PATTERNS.
W.C.Ellis, H.J.Williams and R.C.Sherwood.
J. appl. Phys., Vol. 29, No. 3, 534-6 (March, 1958).

MnBi crystals were prepared by crystallization in a temperature gradient from a liquid solution of bismuth saturated with manganese. Informative domain patterns were developed on surfaces of a crystal by the normal Kerr magneto-optic effect and by the Bitter technique. Block patterns, obtained in some instances, were interpreted as evidence for subgrain structure. A.

538.245

8929. SIZE DEPENDENCE OF THE WALL CHARACTERISTICS IN A TWO-DOMAIN IRON PARTICLE. H.Amar.
J. appl. Phys., Vol. 29, No. 3, 542-3 (March, 1958).

The study of the energy per unit volume v. wall width in a cubic two-domain iron particle leads to the following results: (1) The width and energy per unit area of the wall have values considerably different from their values in bulk iron. (2) The width of the wall slowly rises with increasing size of the cube while the energy decreases. (3) The two-domain configuration is energetically unstable when the cube edge is less than 200 A, in fair agreement with current single domain criteria. A.

538.245

8930 CONSTRAINT PRINCIPLE IN FERROMAGNETIC DOMAIN THEORY. L.Gold.
J. appl. Phys., Vol. 29, No. 3, 544-5 (March, 1958).

The need for a constraint principle is demonstrated by a more precise analysis of the classic Landau-Lifshits (LL) domain configuration. A constraint minimization of the (LL) configuration leads to the requirement of increasing wall thickness in vanishingly small specimens. The Néel–Kaczer theory (NK), based on wall magnetostatic energy, also predicts variable wall thickness. But (NK)

theory is formulated for (infinite) sheet thicknesses well above the thin film region and it requires a gradual fall-off of wall size as the sheet thickness diminishes. The constraint calculation is characterized by a precipitous wall increase as the single-domain realm is approached, a type of behaviour that may have been observed in thin film experiments. A.

538.245

8931. DIRECT MEASUREMENT OF THE VELOCITY OF PROPAGATION OF A FERROMAGNETIC DOMAIN BOUNDARY IN "PERMINVAR". E.W.Lee and D.R.Callaby.
Nature (London), Vol. 182, 254-5 (July 26, 1958).

The radial velocity of a single circular domain wall in an annular specimen of Perminvar was measured using the Kerr effect to detect the passage of the wall across illuminated portions of the specimen. For small driving fields the velocity obeys the relation $V = G(H - H_c)$, where H_c was found to be 0.108 oersted and G about 23 cm sec^{-1} $oersted^{-1}$ — a value in good agreement with that calculated for a plane domain wall. A.E.De Barr

538.27 : 538.652 : 539.32

8932. MAGNETOSTRICTION AND ELASTIC PROPERTIES OF FERROMAGNETIC SUBSTANCES AT HIGH MAGNETIC FIELDS. H.Sato.
J. appl. Phys., Vol. 29, No. 3, 456-8 (March, 1958).

The manner in which the anisotropic forced magnetostriction contributes to the magnetostriction of ferromagnetic substances at high magnetic fields is discussed from a localized model of ferromagnetism. With this assumption, the free energy of a ferromagnetic substance can be conveniently divided into several terms and it can be concluded quite naturally that a free-energy term corresponding to that of ferromagnetic anisotropy gives rise to an anisotropic forced magnetostriction. In the past, the isotropic forced volume magnetostriction has been considered to be the only cause of the forced magnetostriction. This is probably one reason for the discrepancies between the experimental value of the volume magnetostriction and the theoretical value expected from the pressure dependence of the Curie point, etc. From a similar point of view, anomalous behaviour of elastic properties of a ferromagnetic substance, such as the change of the temperature coefficient of the elastic constants at the Curie point, the dependence of the elastic constants upon the direction of the magnetic field, etc., are explained as an intrinsic change in the elastic constants with spontaneous magnetization. In the past, these effects have been explained only as a result of the deformation of the crystal lattice due to the spontaneous magnetostriction (volume effect, morphic effect). A.

ELECTROMAGNETISM. ELECTRODYNAMICS

538.3

8933. INVARIANT PLANES OF ELECTRODYNAMICS. M.Kohler.
Z. Phys., Vol. 150, No. 1, 118-22 (1958). In German.

Results derived in a previous paper (Abstr. 9764/1957) on invariant planes are generalized. It is shown that both bands of planes exist only when the condition $M^*_{ik}P^k = 0$ (where M^*_{ik} is the dual six-vector and P^k the four-current-density of the electromagnetic field) is fulfilled throughout the whole field. No special assumptions about the metric of the space are necessary. The general formulation includes the previous results for the current and charge free case. The rank of the matrix of M_{ik} is taken to be 2.

M.J.Kearsley

538.3 : 532.5 : 550.38

8934 A CLASS OF SELF-SUSTAINING DISSIPATIVE SPHERICAL DYNAMOS. G.Backus.
Ann. Phys. (New York), Vol. 4, No. 4, 372-47 (Aug., 1958).

In a rigorous treatment of the dynamo equations for a bounded volume of incompressible fluid with finite electrical conductivity, it is shown that the dipole moment of an external magnetic field can be maintained or amplified by suitable solenoidal fluid velocities. The dynamo equations are reduced to the form of two scalar heat equations coupled by a heat source term, and precise results for the magnetic field are derived with the help of certain variational inequalities. It is shown that a rapid axisymmetric shear flow produces a large toroidal magnetic field T from a small poloidal field P, together with some unwanted fields R; by stopping the fluid motion the fields R decay rapidly, leaving an appreciable field T. Energy is transferred back to P by non-axisymmetric fluid flow, and fluid motion is stopped again to allow for the decay of unwanted fields. An external dipole field can be maintained indefinitely by repetition of this motion. Some important general results are established: "Fluid motions in a sphere can be regarded as bounded linear operators on the Hilbert space of magnetic fields with finite total energy. The free-decay modes are complete in that space." And "The magnetic effect of any motion can be approximated with arbitrary accuracy by replacing it by a series of rapid jerks interspersed with periods of rest." R.A.Newing

538.3 : 532.5

8935. NOTE ON HYDROMAGNETIC WAVES PASSING THROUGH AN ATMOSPHERE WITH A DENSITY GRADIENT. R.Weymann and R.Howard.
Astrophys. J., Vol. 128, No. 1, 142-5 (July, 1958).

A brief report of an investigation into wave propagation in a polytropic atmosphere overlaid by an isothermal atmosphere in the presence of uniform gravitational and magnetic fields. Results are given for "quasi-acoustic" and "quasi-Alfvén" waves.

R.A.Newing

538.3 : 532.5

8936. VARIATIONAL APPROACH TO MAGNETOHYDRODYNAMICS. P.Rosen.
Phys. of Fluids, Vol. 1, No. 3, 251 (May-June, 1958).

It is shown that the variational principle

$$\delta\left[\int \Psi d\tau + \int j^2 / 2\sigma d\tau\right] = 0$$

(where Ψ is the viscous dissipation function, j the current density and σ the conductivity) subject to constant electromagnetic fields gives, for variations in the current and the velocity, the equations of motion for a viscous incompressible plasma. R.O.Davies

538.3 : 532.5 : 550.38

GEOMAGNETIC DYNAMOS. See Abstr. 8538

538.3 : 532.5 : 551.510.535

MAGNETO-HYDRODYNAMIC WAVES IN THE IONOSPHERE. See Abstr. 8548

538.541 : 621.318.13

8937. CALCULATION OF THE ENERGY LOSS IN MAGNETIC SHEET MATERIALS USING A DOMAIN MODEL. R.H.Pry and C.P.Bean.
J. appl. Phys., Vol. 29, No. 3, 532-3 (March, 1958).

The energy loss resulting from eddy currents is calculated for magnetic sheet materials with a simple domain configuration. The domain model used is considered to be applicable for any induction up to saturation and for the frequency range up to that used in most electrical power applications. The eddy-current losses were calculated explicitly for the case of sinusoidal induction excitation, and expressed in terms of the ratio of domain wall spacing to sheet thickness. The results are in a form more suitable for quantitative comparison with measured values on materials, such as grain oriented silicon iron, than was available before. A.

ELECTROMAGNETIC WAVES AND OSCILLATORS

538.561

8938. EFFECTS OF RADIATION DAMPING ON SPIN DYNAMICS. S.Bloom.
J. appl. Phys., Vol. 28, No. 7, 800-5 (July, 1957).

When a two-state quantum system, capable of making radiative transitions, is driven by a high-frequency field, there occur damping effects due to the reaction of the sample to its own radiated field. This damping, which becomes important for high-Q r.f. structures and for samples of large d.c. susceptibilities, is here analysed classically for a simple prototype system — a magnetic spin system obeying the Bloch equations. These equations are augmented to include the radiation-damping torques and are then solved for the four cases of usual interest. First, for steady-state slow passage, radiation damping broadens and lowers the absorption and dispersion signals. Secondly, for adiabatic fast passage, damping causes the dispersion signal to dip at the line centre and causes the otherwise absent absorption signal to become finite. However, if the radiation damping field becomes larger than the r.f. driving field a complete adiabatic inversion is shown to be no longer possible. Thirdly, the

conditions for the occurrence of delayed power peaks of the free-precession signal are discussed. Fourthly, for the case of the driven non-steady state the stimulated emission may, for large radiation damping, become quite large if the system is driven from an initially "negative temperature" condition. A.

538.561 : 621.318.12 : 621.372.413

8939. RETARDATION EFFECTS CAUSED BY FERRITE SAMPLE SIZE ON THE FREQUENCY SHIFT OF A RESONANT CAVITY. J.E.Tompkins and E.G.Spencer.
J. appl. Phys., Vol. 28, No. 9, 969-74 (Sept., 1957).

Using perturbation theory, expressions are derived for the frequency shift of a circularly polarized resonant microwave cavity upon insertion of a ferrite sample small compared with the wavelength. Retardation effects are considered in deriving the r.f. field h_2 internal to the sample. By integrating $h_1 \cdot h_2 dv$ (where h_1 is the applied r.f. field) over the sample volume, a closed-form expression is obtained for the cavity frequency shift. The theory is applied to the magnetic resonance in ferrites. The calculated magnetic resonance line shape is found to remain symmetrical as the sample size is increased. Retardation effect, thus, does not explain the asymmetry of the resonance lines which were observed for polycrystalline ferrite. Results of the theory are also compared with measurements on a single crystal of ferrite having the rather large maximum permeability loss term of 100. Theoretical and measured values are in close agreement. The theory is also compared with the somewhat different results of other recent theoretical treatments, in which an approximate expression for an effective magnetic dipole moment for the sample was computed, rather than integrating the internal r.f. fields over the volume of the sample. A.

538.561 : 621.375.9

8940. GAIN, BAND WIDTH, AND NOISE CHARACTERISTICS OF THE VARIABLE-PARAMETER AMPLIFIER. H.Heffner and G.Wade.
J. appl. Phys., Vol. 29, No. 9, 1321-31 (Sept., 1958).

The variable parameter principle of amplification is characterized by a typical arrangement in which a variable energy storage element, such as an inductor or a capacitor, is suitably coupled to two resonant circuits. If the value of the energy storage element is made to vary in the proper way, energy is fed from the source which drives the element (that is, the pump) to the fields of both the resonant circuits. It is shown that to increase gain, the Q of one of the resonant circuits (the idling circuit) must be increased or the variation in the variable reactance must be increased. The bandwidth is inversely proportional to this Q and to the voltage gain. Hence, for high gain, the amplifier is normally a narrow band device. One of the most important sources of noise is the thermal noise originating in the idling circuit. However, in principle, this source can be reduced indefinitely by making the idling frequency approach the pumping frequency or by artificially cooling the idling circuit. In this fashion very low noise figures should be possible. The parametric principle can also be applied to producing frequency conversion with large conversion gain. The appendix presents the expressions for gain, bandwidth, and noise figure for this application. The behaviour of the converter relative to gain, bandwidth, and noise is quite similar to that of the amplifier. A.

538.561 : 621.375.9

8941. NOISE IN MASER AMPLIFIERS — THEORY AND EXPERIMENT. J.P.Gordon and L.D.White.
Proc. Inst. Radio Engrs, Vol. 46, No. 9, 1588-94 (Sept., 1958).

This paper contains a theoretical treatment of noise in maser amplifiers and the results of experimental measurements of the noise of an ammonia beam maser. The concept of "effective input noise temperature" is defined and used. The theoretical treatment obtains an equivalent microwave circuit and derives expressions for the gain and effective input noise temperature of both reflection and transmission-type masers. The experimental measurements yielded values of about 80°K for the effective input noise temperature of a reflection-type ammonia beam maser. The experimental values agree with those predicted by theory and the comparison of experiment and theory gives an upper limit of about 20°K for the magnitude of the "beam temperature". A.

538.561 : 621.375.9

8942. A MOLECULAR AMPLIFIER AND GENERATOR OF SUB-MILLIMETRE WAVES. A.M.Prokhorov.
Zh. éksper. teor. Fiz., Vol. 34, No. 6, 1658-9 (1958). In Russian.

The rotational transition of molecular ammonia is used at a wavelength of 0.5 mm. It is shown that an amplification of 2.2×10^4 in power is possible by transmitting between two horns and passing through a beam of molecular ammonia. The behaviour of a parallel plate resonant system is also examined and it is concluded that reflection losses at the surfaces play a significant part in determining the condition of self oscillation. A Q-factor of 2400 is adequate in an oscillator at this wavelength. S.C.Dunn

538.561 : 539.19

ANALYSIS OF A MULTIPOLE STATE SEPARATOR AND FOCUSER FOR POLARIZABLE MOLECULES. See Abstr. 9100

538.563 : 536.33.08 : 551.508.25 : 621.317.39

CAPACITOR MICROPHONE AS A RADIATION DETECTOR. See Abstr. 9184

538.565

8943. A NEW METHOD OF DETERMINING THE TOPOGRAPHY OF HIGH FREQUENCY FIELDS IN CAVITY RESONATORS. O.O.Halkin and P.A.Bezuhlyĭ.
Ukrayin. fiz. Zh., Vol. 1, No. 4, 382-8 (1956). In Ukrainian, with summary (2 p.) in Russian.

A rectangular resonator is employed in which H_{101} oscillations are excited. The resonator has two holes drilled in the upper part to accommodate connections to an h.f. generator and to a detector. The detected signal is amplified and shown on a cathode ray oscillograph. A hole in the bottom of the resonator has a movable polystyrene rod passing through it of length 40 cm and carrying a free probe on its end of volume 1 mm^3. The resonator was arranged in a constant and uniform magnetic field and set oscillating. For $H_{\nu\perp}$ H the intensity of the resonance line depends on the intensity of h.f. field By having the probe at various positions in the resonator it was possible to establish the relative intensities of the h.f. field. C.R.S.Manders

538.566 : 537.56

8944. ON THE PROPAGATION OF ELECTRICAL WAVES ALONG A DIELECTRICALLY BOUNDED PLASMA LAYER WITH A LONGITUDINAL MAGNETIC FIELD. W.O.Schumann.
Z. angew. Phys., Vol. 10, No. 1, 26-31 (Jan., 1958). In German.

When the electron cyclotron frequency Ω is smaller than the plasma frequency ω_0 a possible wave-type is found which starts at $\omega = 0$ with the phase velocity c and ends at $\omega^2 = (\Omega^2 + \omega^2)/2$ with the phase velocity zero. If $\Omega > \omega$ this type remains unchanged, from $\omega = 0$ to $\omega = \omega_0$; for $\omega > \omega_0$ there can be no propagation. H.Motz

538.566 : 539.17 : 621.396.823

ELECTROMAGNETIC NOISE AND PROPAGATION OBSERVATIONS IN THE VICINITY OF A NUCLEAR REACTOR. See Abstr. 8365

538.566 : 530.12

EFFECT OF A GRAVITATIONAL FIELD ON THE PLANE OF POLARIZATION OF AN ELECTROMAGNETIC WAVE. See Abstr. 8578

538.566

8945. DIFFRACTION OF A PLANE ELECTROMAGNETIC WAVE BY A SEMI-INFINITE PERFECTLY CONDUCTING SHEET. P.Poincelot.
C.R. Acad. Sci. (Paris), Vol. 246, No. 25, 3418-19 (June 23, 1958). In French.

It is shown that Sommerfeld's solution satisfies the condition at the edges, proposed by Meixner and discussed in a previous note (Abstr. 7209/1958). P.M.Davidson

538.566 : 537.56

8946. THE "FOURTH REFLECTION CONDITION" OF ELECTROMAGNETIC WAVES IN A PLASMA. K.Rawer and K.Suchy.
C.R. Acad. Sci. (Paris), Vol. 246, No. 25, 3428-30 (June 23, 1958). In French.

The previous derivation of formulae for the dispersion of an e.m. wave in a plasma under the influence of a constant magnetic field and in the presence of thermal movements was considered. It was found that the inclusion of a term generally neglected in the Boltzmann equation modifies the expression for the refractive index, and resolves the problem of its value for the so-called fourth condition of reflection. G.M.Brown

538.566 : 621.396.677.85

8947. METHODS OF REDUCING CHROMATIC ABERRATION IN METAL-PLATE MICROWAVE LENSES. E.K.Proctor.
I.R.E. Trans Antennas and Propagation, Vol. AP-6, No. 3, 231-9 (July, 1958).

Microwave lenses of the waveguide type are subject to a pronounced degree of chromatic aberration because of the inherent dis-

persion of the waveguides. However, this aberration can be substantially eliminated over an appreciable bandwidth by making the lens of slot-loaded ridged waveguides with special properties. This type of lens design makes it possible to achieve additional benefits as well, such as improved scanning capability and elimination of discontinuities in the surfaces at the junction of adjacent "zones" or "steps". The ridged waveguides are periodically loaded by means of transverse slots in the ridges. The ridges may be relatively wide and hollow, or quite thin and solid. Additional desirable properties are obtainable by placing a relatively small strip of dielectric material above the ridge. Experimental data on the propagation characteristics of several of these structures and on the effect of varying such parameters as ridge height, slot width, slot depth, slot spacing, frequency, and size of dielectric strip are given. An analysis of the phase errors which result from changes in the operating frequency shows that the aberrations may conveniently be separated into one type in which the phase front from each zone of the lens is distorted, and a second independent type in which the desired phase relationship between the zones is destroyed. Methods of eliminating either or both of these types of aberration by suitable design of the ridged waveguides are described. In addition, it is shown how the ridged waveguides can conveniently be used to achieve "zoning" or "stepping" by changing the effective index of refraction, thereby eliminating discontinuities in the lens surfaces and avoiding the undesirable diffraction which would otherwise occur at the boundaries between adjacent zones. The superiority of this type of lens structure in wide-angle scanning applications is also discussed. Numerical examples which illustrate the advantages of the loaded ridged waveguide lens are included. A.

538.566 : 621.372.822 : 621.317.34

8948. DETERMINATION OF HIGHER ORDER PROPAGATING MODES IN WAVE-GUIDE SYSTEMS. M.P.Forrer and K.Tomiyasu.
J. appl. Phys., Vol. 29, No. 7, 1040-5 (July, 1958).

A measuring technique is described for the quantitative determination of all propagating modes, both dominant and of higher order, in a straight, lossless, rectangular waveguide. Calibrated probes are used to measure the amplitude and phase of the electric fields at various locations on the waveguide walls. The number of probe locations must be equal to or greater than the number of propagating modes at the frequency being considered. The measuring technique revealed that 31 kW peak power at the third harmonic (X-band) was radiated by a 5 MW S-band magnetron. A.

538.566 : 621.396.67

8949. MINIATURIZED RESONANT ANTENNA USING FERRITES. D.M.Grimes.
J. appl. Phys., Vol. 29, No. 3, 401-2 (March, 1958).

For very small ferrite spheres, the radiation resistance is determined by the relative permittivity; the effective reactance length by both the permittivity and the permeability. Thus it is possible to exchange length for resistance. Further work on linear radiators surrounded by ferrite in the form of a prolate figure of revolution is indicated. A.

538.566 : 621.37

8950. ABSORPTION OF ELECTROMAGNETIC WAVES WITH THE HELP OF LOADED RESONANT SLOTS. F.Wiekhorst.
Z. angew. Phys., Vol. 10, No. 4, 173-8 (April, 1958). In German.

Describes development of exceptionally thin wideband absorbers for microwaves, consisting finally of a grid of heavily damped overtuned dipoles situated between a lossy film with under-tuned slots and a metal plate. Insensitivity to polarization is achieved by using circular slots. Experimental tests give reflection coefficients of less than 5% for a wavelength range from less than 3.5 to 3.8 cm. B.Meltzer

538.566.2 : 621.371

8951. RECIPROCITY RELATIONSHIPS FOR GYROTROPIC MEDIA. R.F.Harrington and A.T.Villeneuve.
I.R.E. Trans Microwave Theory and Tech., Vol. MTT-6, No. 3, 308-10 (July, 1958).

Reversal of the d.c. magnetic field in gyrotropic media transposes the tensor permeability and permittivity. It is shown that this also transposes the impedance, admittance, and scattering matrices of any device. It follows from this that the usual reciprocity statements for isotropic media apply to gyrotropic media if one reverses the d.c. magnetic field whenever an interchange of source and measurer is made. A.

538.566.2 : 551.594.221

CORRELATION OF WHISTLERS AND LIGHTNING FLASHES BY DIRECT AURAL AND VISUAL OBSERVATION. See Abstr. 8558

538.567

8952 PARAMAGNETIC FARADAY EFFECT.
J.Soutif-Guicherd.
J. appl. Phys., Vol. 29, No. 3, 256-8 (March, 1958).

A theory is given for the Faraday rotation in paramagnetic salts and curves for the rotation angle as a function of applied field are calculated. For comparison with theory, results are given of measurements made on several manganese salts at a wavelength of 9 9 cm, and the agreement is good. A.

538.569

8953. SURFACE CURRENTS INDUCED BY SHORT-WAVELENGTH RADIATION. J.A.Cullen.
Phys. Rev., Vol. 109, No. 6, 1863-7 (March 15, 1958).

The integral equation given by Fock for the surface currents induced in a perfectly conducting convex object by short-wavelength plane electromagnetic waves is solved directly by the method of Fourier transforms. The result agrees with Fock's indirect approach. Some general properties of the equation are also discussed. A.

NUCLEAR AND ATOMIC PHYSICS APPARATUS. PARTICLE DETECTORS

539.1.07 : 537.562

8954. THE STATISTICS OF ELECTRON AVALANCHES IN PROPORTIONAL COUNTER TUBES. IV. H.Schlumbohm.
Z. Phys., Vol. 152, No. 1, 49-58 (1958). In German.

For Pt III, see Abstr. 8834 (1958). The present work relates to cylindrical (radially symmetrical) geometry. A special counter tube is described and results for avalanche sizes etc. are given for methane and methylal. There is a detailed discussion. J.D.Craggs

539.1.07 : 535.376

APPLICATION OF LUMINESCENCE CHANGES IN ORGANIC SOLIDS TO DOSIMETRY. See Abstr. 8703

539.1.07 : 518.5

8955. ELECTRONIC COMPUTER FOR MASS IDENTIFICATION OF PARTICLES. W.L.Briscoe.
Rev. sci. Instrum., Vol. 29, No. 5, 401-4 (May, 1958).

A circuit is described for identifying protons, deuterons and tritons. The identification is accomplished by obtaining the product of the energy and the initial space rate of energy loss. The product is modified so that each type of particle gives a unique result in the form of an output pulse having an amplitude nearly proportional to the mass of the particle. The circuit as given is capable of handling input pulses as narrow as 1 μsec, although shorter pulses may be used if some test features are eliminated. The multiplying operation is performed by QK-329 tubes (beam deflection tubes), using the principle of difference of squares. A.

539.1.07

8956. STABLE MULTICHANNEL POSITIVE PION DETECTOR.
W.Imhof, R.Kalibjian and V.Perez-Mendez.
Rev. sci. Instrum., Vol. 29, No. 6, 476-9 (June, 1958).

A $\pi-\mu$ decay counter was designed and used to count positive pions in several synchrotron and cyclotron experiments. Utilizing an improved gate generator and coincidence circuit, the detector possesses a very stable efficiency for counting pions in several energy intervals. The detector is readily adaptable to the addition of extra counters to permit the detection of pions in the presence of large backgrounds. A.

539.1.07

8957. PULSED CYCLOTRON METHOD FOR 2-25 MeV NEUTRON SPECTROSCOPY. J.E.Draper.
Rev. sci. Instrum., Vol. 29, No. 2, 137-42 (Feb., 1958).

A method is described for obtaining short intense bursts (5 mμsec and 10-20 mA) of 22 MeV deuterons at a repetition rate of 500 c/s. The cyclotron arc is pulsed on for 1 μsec, and one of the approximately ten circulating phase-grouped beam bunches is selected for deflection on to the external cyclotron target by means of a 50 mμsec pulse on the cyclotron deflector. Using a 12.5 m flight-path the resulting radiations were analysed. Investigations of backgrounds showed them to be less than 1%. A.

539.1.07

8958 APPARATUS FOR MEASURING THE ENERGY SPECTRA OF MASS-SELECTED PARTICLES IN COINCIDENCE WITH FISSION. R.H.Stokes, J.A.Northrop and K.Boyer.
Rev. sci. Instrum., Vol. 29, No. 1, 61-4 (Jan., 1958).

An apparatus used to observe the energy spectrum of protons in coincidence with 14 MeV deuteron-induced fission is described. One feature is a mass identifier which operates over a range from 5 to 25 MeV, and gives good separation of protons, deuterons and tritons. Its operation depends on measuring the particle energy loss ΔE in a transmission counter and the residual energy E in a separate counter. The E and ΔE pulses are introduced into an electronic computer which in 1 μsec produces a pulse whose height is closely proportional to mass. The accuracy of mass separation is illustrated by a representative case in which less than 0.1% of the elastically scattered deuterons appear in the proton energy spectrum. In the presence of the complicating effects of cyclotron beam modulation, the chance coincidence correction to the proton-fission coincidence spectrum is made by simultaneously measuring the delayed and undelayed spectra. A.

539.1.07

8959. PHOTOPROTON SCINTILLATION SPECTROMETER. A.Whetstone, B.Allison, E.G.Muirhead and J.Halpern.
Rev. sci. Instrum., Vol. 29, No. 5, 415-19 (May, 1958).

An apparatus is described for the measurement of the energy and angular distribution of protons from (γ,p) reactions. A method is presented for obtaining energy spread of 3% for protons from 5 to 15 MeV with a NaI scintillator of 1 in. diameter aperture. Energy calibration of the detector with mono-energetic protons gives an energy v. pulse-height line having an intercept of 0.46 ± 0.10 MeV. The ratio of α particle to proton energy for equal pulse-heights is found to be 1.93 ± 0.04 for 4.48 MeV α particles. A CsI scintillator, similarly mounted, yields an intercept of -0.17 ± 0.15 MeV and an α-proton energy ratio of 1.66 ± 0.07 for 5.3 MeV α particles. A modification of the Thoswich to provide discrimination against electrons is described. A.

539.1.07 : 538.083.9 : 621.317.444

DIRECT QUARTZ CRYSTAL CONTROL OF A LOW-LEVEL POUND–KNIGHT–WATKINS SPIN MAGNETOMETER. See Abstr. 8858

ELEMENTARY PARTICLES

539.12 : 519.25 : 518.4

ANALYTICAL REPRESENTATION OF ANGULAR DISTRIBUTION DATA. See Abstr. 8566

539.12 : 530.145

INTERACTION OF ELEMENTARY PARTICLES. See Abstr. 8580

539.12

8960. BREMSSTRAHLUNG OF VERY LOW-ENERGY QUANTA IN ELEMENTARY PARTICLE COLLISIONS. F.E.Low.
Phys. Rev., Vol. 110, No. 4, 974-7 (May 15, 1958).

It is shown that the first two terms in the series expansion of the differential bremsstrahlung cross-section (in powers of the energy loss) may be calculated exactly in terms of the corresponding elastic amplitude and the electromagnetic constants of the participating particles. A.

539.12

8961. POLARIZATION AND ANGULAR CORRELATION IN THE PRODUCTION AND DECAY OF PARTICLES OF SPIN $\frac{1}{2}$ AND SPIN $\frac{3}{2}$. R.Spitzer and H.P.Stapp.
Phys. Rev., Vol. 109, No. 2, 540-6 (Jan. 15, 1958).

Some relationships describing the angular correlation and polarization effects in the production and susbsequent decay of particles of arbitrary spins are given. They are specialized to the cases of production and decay of particles of spin $\frac{1}{2}$ and $\frac{3}{2}$. Expressions for the angular distribution and polarization of the decay products are reduced to tractable forms involving the physical vectors of the problem and a minimal number of parameters describing the production and decay interactions. The information that may be obtained from the analysis of the angular correlations of the decay products is discussed. A.

539.12 : 530.19 : 539.166.07

8962. GAMMA-RAY COLLIMATOR PENETRATION AND SCATTERING EFFECTS. R.L.Mather.
J. appl. Phys., Vol. 28, No. 10, 1200-7 (Oct., 1957).

Expressions are developed which give the amount of unidirectional radiation from a distant radiation source passing through a cylindrical hole in a slab of material, including the amount of radiation which penetrates the edges of the hole, as a function of angle between the radiation direction and the axis of the hole. The modifications necessary for sources at finite distances are indicated. These functions are integrated over appropriate angles for distant line sources, and for extended sources. It is shown that, to a first approximation, the results are the same as the geometrical aperture for a like diameter hole in a similar slab with one mean free path of material removed from each side. The effects due to scattering from the walls of the collimator are discussed and an approximate method of calculation is presented with results for a specific collimator. A.

539.12

8963. DISPERSION RELATIONS FOR COMPTON SCATTERING. R.E.Prange.
Phys. Rev., Vol. 110, No. 1, 240-52 (April 1, 1958).

The perturbation formulae for Compton scattering with radiative corrections are written as dispersion relations. The purpose is to learn something about (1) the number of subtractions that are needed in the relations, (2) the analytic continuation of the scattering amplitude into the unphysical region, and (3) the role of the infrared divergence. It is found that one subtraction is needed to obtain dispersion relations but that these equations still depend on the fictitious mass of the photon. To obtain relations which contain only physical quantities another subtraction is made. It is suggested that the imaginary part of the amplitude has fewer singularities than the amplitude itself, and consequently may, in some cases, be continued by means of the phase-shift expansion. Finally, it is shown that the Born approximation is equivalent to the so-called one-electron-intermediate-state contribution to the dispersion relation. A.

539.12

8964. CALCULATION OF ENERGY DISSIPATION BY GAMMA RADIATION NEAR THE INTERFACE BETWEEN TWO MEDIA. M.J.Berger.
J. appl. Phys., Vol. 28, No. 12, 1502-8 (Dec., 1957).

A Monte Carlo calculation was made of the energy dissipation by gamma radiation in a medium, with the scattering properties of water, which consists of two semi-infinite regions, one of which is much denser than the other. The calculations are for a 1.28 MeV point-isotropic source at or near the boundary plane separating the two regions. The results are presented in terms of boundary correction factors which express the change of energy dissipation compared to that prevailing at the same location in a medium of uniform density. The analysis of the results leads to the conclusion that the boundary effect is rather insensitive to the atomic number of the medium, and is mainly a function of the density change. The Monto Carlo results are in good agreement with an experiment of Soole (Abstr, 7337/1955) on the propagation of radiation in the air above the ground, and an experiment on the dose distribution in iron. A.

539.12 : 539.17

ATTENUATION OF γ-RAYS FROM AN INFINITE PLANE. See Abstr. 8366

539.12

8965. EXPERIMENTAL LIMIT OF THE NEUTRINO REST MASS. L.Friedman.
Phys. Rev. Letters, Vol. 1, No. 3, 101-2 (Aug. 1, 1958).

A reply to Sakurai (Abstr. 6121/1958). Explains basis of estimate of the order of 1 keV for the empirical upper limit for the neutrino rest mass (see Abstr. 6361/1958). E.J.Burge

539.12

8966. BREMSSTRAHLUNG CROSS-SECTION MEASUREMENTS FOR 50 keV ELECTRONS. J.W.Motz and R.C.Placious.
Phys. Rev., Vol. 109, No. 2, 235-42 (Jan. 15, 1958).

The dependence of the bremsstrahlung differential cross-section on photon energy and angle for 50 keV electrons ($\beta_0 \cong 0.4$) incident on a 10 $\mu g/cm^2$ gold target and a 17 $\mu g/cm^2$ aluminium target was determined from measurements made with a scintillation spectrometer at angles ranging from 10 to 140 degrees. The experimental results are compared with the Sommerfeld–Kirkpatrick–Wiedmann cross-sections multiplied by the relativistic correction factor $(1-\beta_0 \cos\theta)^{-2}$. For high photon energies (45 keV), the experimental

results show good agreement with the theory at the peak intensity angles, approximately 50 and 60 degrees for gold and aluminium, respectively, but at the extreme angles there are differences of about 50% with the theory. For low photon energies (10 keV), discrepancies with the theory also increase at the extreme angles, with maximum differences of about 30% for aluminium and 40% for gold. Good agreement is obtained between theory and experiment over the whole angular range for 45 keV photons emitted from the aluminium target, when rough estimates of retardation and screening effects are also included in the theory. The experimental values for the Heitler parameter, $\phi_{rad}/\bar{\phi}$, are 5.5 ± 0.6 and 6.7 ± 0.7 for aluminium and gold respectively, compared to the theoretical value (including the above relativistic correction factor) of approximately 6.9 for both aluminium and gold. A.

539.12 : 537.564

ENERGY TO PRODUCE AN ION PAIR IN VARIOUS GASES BY BETA PARTICLES. See Abstr. 8845

539.12 : 539.18

SPIN RESONANCE OF FREE ELECTRONS. See Abstr. 9076

539.12

8967. LARGE-ANGLE ELECTRON PAIR PRODUCTION FROM HYDROGEN. B.Richter.
Phys. Rev. Letters, Vol. 1, No. 3, 114-16 (Aug. 1, 1958).

The pair production cross-section from protons was measured by detecting the 70 MeV positrons produced at 90° to a 137 MeV peak energy bremsstrahlung beam. It was found to be 0.96 ± 0.14 of a value predicted by Bjorken, Drell and Frautschi, and could be interpreted as setting an upper limit of about 0.9 fermi to the distance at which the present theory of quantum electrodynamics breaks down. E.J.Burge

539.12

8968. THE RANGE OF LOW-ENERGY ELECTRONS AND POSITRONS IN ALUMINIUM. K.Gubernator.
Z. Phys., Vol. 152, No. 2, 183-93 (1958). In German.

The "maximum ranges" of monoenergetic electrons and positrons were measured in the range 10-160 keV, and were found to obey the range–energy relations $R^- = 773\ E^{1.70}$ for electrons, $R^+ = 759\ E^{1.72}$ for positrons (R in mg/cm², E in MeV). The ratio $R^+/R^- = 0.982\ E^{0.02}$ agrees within experimental error with the ratio of previously calculated "true ranges". R.J.N.Phillips

539.12 : 535.343

8969. ATTEMPT TO DETECT THE LYMAN α LINE OF THE POSITRONIUM ATOMIC SPECTRUM. R.L.Brock and J.F.Streib.
Phys. Rev., Vol. 109, No. 2, 399 (Jan. 15, 1958).

An unsuccessful attempt to observe the 2430 A Lyman α-line of the positronium atom is described. The construction of the source was based on the assumption that occasionally a slow positron at the surface of a metal will capture an electron to form an excited positronium atom which will emerge and radiate. A.

539.12

8970. DEPOLARIZATION OF A POSITRON BEAM BY MULTIPLE SCATTERING. S.M.Neamtan.
Phys. Rev., Vol. 110, No. 1, 173-4 (April 1, 1958).

On the assumption of a multiple scattering process, a formula is derived for the depolarization of a positron beam in being slowed down in matter. In its general form, the formula is applicable not only to positrons but to any fermions. A.

539.12 : 539.165.2

POSITRON POLARIZATION IN A MIRROR TRANSITION. See Abstr. 8298

539.12 : 539.165.2

POLARIZATION OF POSITRONS FROM Ga^{66}, Ga^{68}, P^{29}, AND Al^{25}. See Abstr. 8299

539.12 : 538.245

8971. POLARIZATION OF POSITRONS AND ANNIHILATION IN FERROMAGNETIC MATERIALS. S.S.Hanna and R.S.Preston.
Phys. Rev., Vol. 109, No. 3, 716-20 (Feb. 1, 1958).

The angular correlation of two-quantum radiation from annihilation of positrons in ferromagnetic media was investigated as a function of the direction of magnetization. The observed changes in the correlations are attributed to the polarization of positrons emitted from an unpolarized source. In the part of the two-quantum correlation associated with large electron momentum, the yield is greater when the polarization of the positrons is parallel to the magnetic field and it is less when the field is reversed. This effect is enhanced when the initial energy, and hence the polarization, of the positrons increases. The qualitative features of the effect were the same in three samples of iron (one containing a large amount of cobalt). No effect was detected for nickel or gadolinium (below the Curie point), and none for any nonferromagnetic metal which was used as a test of the experiment. A.

539.12

8972 SUMMARY OF HIGH-ENERGY NUCLEON–NUCLEON CROSS-SECTION DATA. W.N.Hess.
Rev. mod. Phys., Vol. 30, No. 2(I), 368-401 (April, 1958).

Measurements of cross-sections and angular distributions (including double- and triple-scattering experiments) above 10 MeV are summarized, with brief details of each experiment and of any later corrections. There is a short discussion of these data. R.J.N.Phillips

539.12

8973. RANGE OF 14 MeV PROTONS IN NUCLEAR EMULSION. F.C.Gilbert, H.H.Heckman and F.M.Smith.
Rev. sci. Instrum., Vol. 29, No. 5, 404-5 (May, 1958).

Neutrons, produced by the reaction $H^3(d,n)He^4$, gave proton recoils in nuclear emulsion whose ranges were used to obtain a calibration point on the range–energy relation. The range for 13.94 ± 0.10 MeV protons in emulsion of density 3.815 g/cm³ is 995.9 ± 2.1 μ. A.

539.12

8974 PROTON POLARIZATION MEASUREMENTS NEAR 18 MeV. K.W.Brockman, Jr.
Phys. Rev., Vol. 110, No. 1, 163-9 (April 1, 1958).

Polarization of protons in proton–helium scattering may be calculated from phase shifts obtained from differential cross-section measurements. Calculations of this type were performed for energies up to 18 MeV. On the basis of these results, an instrument was built with which proton polarizations could be measured for protons with energies from 5 MeV to 18 MeV and beyond. A second polarization analyser was built utilizing the discovery of polarization in the scattering of protons by carbon around 17 MeV. Results are given for polarization measurements on H, D, Be, C, and Al near 18 MeV. Angular distributions for polarization in both elastic and inelastic (4.4 MeV excitation) scattering by carbon are also reported. A.

539.12

8975 EXPERIMENTS ON ANTIPROTONS: CROSS SECTIONS OF COMPLEX NUCLEI.
L.E.Agnew, O.Chamberlain, D.V.Keller, R.Mermod, E.H.Rogers, H.M.Steiner and C.Wiegand.
Phys. Rev., Vol. 108, No. 6, 1545-53 (Dec. 15, 1957).

Experiments are described that were designed to measure separately annihilation and reaction cross-sections for antiprotons of approximately 450 MeV on oxygen, copper, silver, and lead. A spectrograph was built for this experiment. The antiproton cross-sections are compared with total proton cross-sections, and are found to be larger by a factor varying from 1.74 for oxygen to 1.39 for silver. Calculations based on the optical model give a reasonable connection between these cross-sections and the $\bar{p}$–p and $\bar{p}$–n cross-sections. The information available on antiproton production cross-sections is collected. There are indications that a free nucleon is several times as effective as a bound one for producing antiprotons. A.

539.12

8976. INCOHERENT ELECTRON SCATTERING FROM THE NUCLEONS IN BERYLLIUM AND CARBON AND THE MAGNETIC SIZE OF THE NEUTRON. H.F.Ehrenberg and R.Hofstadter.
Phys. Rev., Vol. 110, No. 2, 544-50 (April 15, 1958).

The electron scattering at high momentum transfer was measured from the nucleons in Be, in C, and from the free proton. The data yield the cross-section of the average nucleon and of the neutron in relation to that of the proton. $\sigma_n/\sigma_p(\theta)$ is found to be 1.16 ± 0.3 at 500 MeV and 135°; it decreases, as expected, for smaller angles and lower energies. If the assumption is made that meson-exchange effects and interactions in the final state are not important, the form factors obtained indicate an apparent root-mean-square radius of the neutron's magnetic-moment distribution of (0.53 ± 0.15) × 10^{-13} cm. It is possible that the apparent small size of the neutron in Be and C is due to the neglect of meson-exchange effects and interactions in the final state. The present result is smaller than a neutron size given by Yearian and Hofstadter, who compared the cross-sections of deuteron and proton and found equal sizes for neutron and proton. If one accepts the latter result, the present experiment can be used to yield a measure of the above neglected effects. A.

539.12

8977. MAGNETIC FORM FACTOR OF THE NEUTRON.
M.R.Yearian and R.Hofstadter.
Phys. Rev., Vol. 110, No. 2, 552-64 (April 15, 1958).

Electron scattering from the bound neutron and proton in the deuteron was studied at various scattering angles between 75° and 135° for 500 MeV and 600 MeV electrons. A comparison of these scattering cross-sections with those of the free proton permits a determination of the density distribution of the magnetic cloud around the neutron. By using theories developed by Jankus and Blankenbecler, the root-mean-square radius of the neutron is shown to lie between the limits 0.80×10^{-13} cm and 0.90×10^{-13} cm. The choice between these radii depends on whether the deuteron total cross-sections or differential (peak) cross-sections are compared with the protonic scattering cross-section. Since presently available theory has not yet developed sufficiently to decide definitely between these possibilities, the root-mean-square size may be taken to be $(0.85 \pm 0.10) \times 10^{-13}$ cm with small error. The neutron's magnetic cloud clearly does not have the small size obtained by measurement of its charge cloud from experiments on the neutron–electron interaction, and this anomaly challenges the present concepts of nucleon size. A.

539.12 : 537.564

IONIZATION YIELD OF PROTONS IN NITROGEN AND ARGON. See Abstr. 8842

539.12

8978. OPTICAL-MODEL ANALYSES OF SCATTERING OF 4.1, 7, AND 14 MeV NEUTRONS BY COMPLEX NUCLEI.
F.Bjorklund and S.Fernbach.
Phys. Rev., Vol. 109, No. 4, 1295-8 (Feb. 15, 1958).

Exact phase-shift calculations were carried out on the UNIVAC for the scattering of fast neutrons by complex nuclei. Both central and spin-orbit potentials are included. At each energy considered, a single set of parameters was found to give fairly good agreement with experimental data. A.

539.12

8979 DIFFERENTIAL CROSS SECTION FOR 3.7 MeV NEUTRONS SCATTERED FROM ZIRCONIUM AND MOLYBDENUM.
H.S.Hans and S.C.Snowdon.
Phys. Rev., Vol. 108, No. 4, 1028-31 (Nov. 15, 1957).

The cross-sections were measured in a ring geometry by using a Bonner-type scintillation detector. The measurements were taken over an angular range of 124 degrees between 18° and 142°. Angular resolution effects were removed by iteration, and multiple scattering effects by a Monte Carlo type calculation. A.

539.12 : 539.2

8980. THERMAL INELASTIC SCATTERING OF COLD NEUTRONS IN POLYCRYSTALLINE GRAPHITE. II.
P.G.Khubchandani, L.S.Kothari and K.S.Singwi.
Phys. Rev., Vol. 110, No. 1, 70-2 (April 1, 1958).

Inelastic scattering cross-section of cold neutrons in polycrystalline graphite is calculated without using the incoherent approximation. The present calculations, though they are an improvement upon those reported in an earlier paper (Abstr. 5747/1957), are still unable to explain satisfactorily the observed variation of cross-section with neutron wavelength. Calculations of some typical scattering surfaces in graphite are also given, revealing some interesting features. A.

539.12

8981. ELASTIC SCATTERING OF NEUTRONS AT SPHERICAL SCATTERER. O.M.Korol'ov and B.D.Konstantinov.
Ukrayin. fiz. Zh., Vol. 2, No. 4, 303-9 (1957). In Ukrainian with summaries (1 p.) in Russian and (½ p.) in English).

A parallel beam of neutrons is considered to fall on a spherical scatterer with a threshold detector at its centre. The number of neutrons of given initial energy entering the detector is calculated for a given neutron flux and inelastic scattering cross-section, also the total neutron flux of given initial energy entering the detector after passing through the spherical scatterer.
C.R.S.Manders

539.12 : 539.19

POTENTIAL CURVES AND ENERGY LEVELS OF THE μ-MESO-MOLECULES (pp)μ, (dp)μ, (dd)μ. See Abstr. 8409

539.12

8982. μ-MESON DECAY WITH NON-CONSERVATION OF PARITY. E.M.Ferreira.
An. Acad. Brasil. Ciênc., Vol. 29, No. 4, 531-4 (1957).

Assuming the decay scheme $\mu \rightarrow e + \nu + \bar{\nu}$, the electron distribution in energy and angle and the polarization of all emitted particles are given for four distinct interactions; the most general parity-violating non-derivative, direct interaction is a linear combination of the latter. R.J.N.Phillips

539.12

8983. ENERGY DEPENDENCE OF POSITRON ASYMMETRY FROM POLARIZED MUON DECAY IN EMULSION.
C.Castagnoli, A.Manfredini and A.W.Merrison.
Nuovo Cimento, Vol. 9, No. 1, 186-7 (July 1, 1958).

Multiple scattering measurements in emulsion were made on 1001 tracks of positrons from $\pi-\mu-e$ decay. The limiting value of the asymmetry coefficient $\bar{\alpha}$ is found to be 0.20 ± 0.04; the energy dependence curve $\alpha\ (>\epsilon) = \bar{\alpha}\ f(\epsilon)$ is found to agree with that predicted by two-component neutrino theory with leptonic charge conservation.
R.H.W.Johnston

539.12 : 539.18

8984. EXPERIMENTAL EVIDENCE FOR THE INFLUENCE OF ATOMIC BINDING ON THE DECAY RATE OF NEGATIVE MUONS.
R.A.Lundy, J.C.Sens, R.A.Swanson, V.L.Telegdi and D.D.Yovanovitch.
Phys. Rev. Letters, Vol. 1, No. 3, 102-4 (Aug. 1, 1958).

Presents preliminary results for the ratio of the rate of decay of negative muons bound in an orbit to a nucleus of charge Z to the rate for Z = 6. The values are between 0.9 and 1.0 for Al, Zn, Mo and Cd, 1.21 for Fe, and 0.53 for W. E.J.Burge

539.12

8985 ELECTRIC DIPOLE MOMENT OF THE MUON.
D.Berley, R.L.Garwin, G.Gidal and L.M.Lederman.
Phys. Rev. Letters, Vol. 1, No. 4, 144-6 (Aug. 15, 1958).

An experiment based on the use of longitudinally polarized beams of muons and the action of muon decay as its own polarization analyser gave a value of 0.006 ± 0.005 in units of $e\hbar/mc$. This is consistent with a vanishing dipole moment expected on the basis of time-reversal invariance. E.J.Burge

539.12

8986. MU-MESON SCATTERING FROM LEAD NUCLEI.
B.Chidley, G.Hinman, P.Goldstein, R.Summers and R.Adler.
Canad. J. Phys., Vol. 36, No. 6, 801-2 (June 1, 1958).

23 MeV negative μ-mesons were scattered in a 0.022 in. lead plate mounted in a propane bubble-chamber. The scattering distribution was found to be in good agreement with the predictions of Molière's theory. S.J.Goldsack

539.12

8987. NEUTRAL PION DECAY.
M.L.Goldberger and S.B.Treiman.
Nuovo Cimento, Vol. 9, No. 3, 451-60 (Aug. 1, 1958).

Neutral pion decay is studied quantitatively with dispersion relation techniques. The process is pictured as proceeding mainly through pion disintegration into baryon pairs, the latter annihilating to produce the photons. Only the nucleon pair is taken into account in detail, as representative of baryon pair contributions generally. The final expression for the decay rate has a structure very different from what one obtains in perturbation theory. It turns out, however, that the numerical results are not appreciably different. A.

539.12

8988. SOLUTIONS OF THE STATIC THEORY INTEGRAL EQUATIONS FOR PION–NUCLEON SCATTERING IN THE ONE-MESON APPROXIMATION. G.Salzman and F.Salzman.
Phys. Rev., Vol. 108, No. 6, 1619-28 (Dec. 15, 1957).

Numerical solutions of the one-meson approximation of the Low equations for elastic pion–nucleon scattering in the fixed-nucleon, extended-source theory are obtained with a Gaussian cut-off function. The validity of the method requires that the scattering amplitudes have no zeros in the complex plane other than at $z = \pm 1$. The functions obtained for the (3,3) and (1,1) states satisfy the Low equations within the accuracy of the method, but the (1,3) and (3,1) states are only approximately given. This difficulty with the (1,3) and (3,1) states is correlated with the development of a zero in the corresponding scattering amplitude well before physically interesting values of the parameters (coupling constant and cut-off) are reached. A best fit to the (3,3)-state data up to 170 MeV pion laboratory energy requires a coupling constant, f^2, less than 0.08. The solution is consistent with the (3,1) state data, but gives a (1,1) state phase shift of larger magnitude than experiment appears to permit. It is found that the cut-off function does not prevent strong interactions at very high energies. Their occurrence appears to be a property of the static model. The contributions of such interactions to

various static-theory calculations is briefly discussed. It is shown that in the p-wave part of the relativistic dispersion relations, where there is no cut-off function, if use is made of the low-energy data, then the very high-energy contributions of the static theory are replaced by recoil terms of order μ/M. A.

539.12

8989. π^--PROTON SCATTERING AT 950 MeV.
A.R.Erwin,Jr and J.K.Kopp.
Phys. Rev., Vol. 109, No. 4, 1364-6 (Feb. 15, 1958).

Approximately 1200 π^-–proton interactions in a liquid-hydrogen bubble chamber were studied to obtain the elastic differential cross-section and inelastic partial cross-sections at 950 ± 20 MeV mean laboratory energy. Relative cross-sections were converted to absolute values using the total cross-section obtained by Cool and co-workers with counters (Abstr. 6915/1954, 8403/1956). The differential cross-section is inconsistent with a resonance of definite total angular momentum and parity and can be fitted by a superposition of partial waves of angular momenta up to 3ħ without spin-flip scattering. In the centre-of-mass system, 30% of the pions scatter beyond a broad minimum of the cross-section at 75°. A.

539.12 : 530.145

8990. π^- SCATTERING AND DISPERSION RELATIONS.
H.-Y.Chiu and J.Hamilton.
Phys. Rev. Letters, Vol. 1, No. 4, 146-7 (Aug. 15, 1958).

In addition to their previous work (Abstr. 5226/1958) further arguments (namely, inclusion of d-waves and re-examination of new experimental data) are brought forward to show that there is no conclusive evidence for a discrepancy in the π^-–p dispersion relations. P.Roman

539.12

8991. PION PRODUCTION IN THE K^+–NUCLEON INTERACTION. C.Ceolin, N.Dallaporta and L.Taffara.
Nuovo Cimento, Vol. 9, No. 2, 353-7 (July 1, 1958).

The ratio of pion-production to scattering for K^+–p interactions is calculated near threshold. It is found to depend rather sensitively on the kind of intermediate states assumed in the calculation. In particular, assuming a four-boson (K,K,π,π) interaction gives a much more rapid increase with energy than in the case of the more conventional K.N.Y. model. R.H.W.Johnston

539.12

8992. ISOTROPY OF PION EMISSION AT 6 BeV. D.T.King.
Phys. Rev., Vol. 109, No. 4, 1344-6 (Feb. 15, 1958).

Observations were made of the angular distribution of energetic electron pairs in nuclear emulsions which were exposed to the internal 6.3 BeV proton beam of the Bevatron. The method by which the pairs were found is discussed. The angular distribution of the pairs is reasonably similar to that of the neutral pions originating in proton–nucleus collisions in the emulsion. Examination of the angular distributions in terms of multiple meson production in nucleon–nucleon collisions indicates that for these observations the emission is consistent with isotropy in the centre-of-mass system. A.

539.12

8993. PHOTOPRODUCTION OF SINGLE POSITIVE PIONS FROM HYDROGEN IN THE 500-1000 MeV REGION.
F.P.Dixon and R.L.Walker.
Phys. Rev. Letters, Vol. 1, No. 4, 142-4 (Aug. 15, 1958).

Partial angular distributions are reported for laboratory photon energies of 600-1000 MeV. Detailed study of the differential cross-section at 90° in the c.m. system between 450 and 900 MeV revealed a prominent peak at 700 MeV suggestive of a second resonance in the π^+-photoproduction and possibly assignable to a $T = \frac{1}{2}$ resonance. E.J.Burge

539.12

8994. A HEAVY NEUTRAL MESON: DECAY AND METHOD OF DETECTION. Ya.B.Zel'dovich.
Zh. éksper. teor. Fiz., Vol. 34, No. 6, 1644-6 (1958). In Russian.

The proposed meson (isotopic spin = 0 = strangeness) has the following allowed modes of decay:

$$\rho \rightarrow \pi^+ + \pi^- + \gamma$$

$$\rho \rightarrow 2\gamma$$

If $m_\rho > 2m_\pi$ the decay mode involving the emission of a single γ is the more probable. The expected lifetime is $10^{-18} - 10^{-20}$ sec. It is suggested that it may be possible to measure m_ρ using the reaction $p + p \rightarrow p + p + \rho$. S.Chomet

539.

8995. Λ^0, θ_1^0, θ_2^0 AND $\overline{\theta}^0$ LIFETIMES.
E.Boldt, D.O.Caldwell and Y.Pal.
Phys. Rev. Letters, Vol. 1, No. 4, 148-50 (Aug. 15, 1958).

The mean life of the Λ^0 was found from 188 events to be $(2.63 \pm 0.21) \times 10^{-10}$ sec and the decay shown to be a simple exponential. 90 θ_1^0 decays gave a mean life for the θ_1^0 of $(1.07 \pm 0.13) \times 10^{-10}$ sec. Evidence is given for the θ_1^0 mode of decay of the $\overline{\theta}^0$. Two definite θ_2^0 decays and three possibles give a mean life for the θ_2^0 of $(9_{-7}^{+8}) \times 10^{-8}$ sec. E.J.Burg

539.1

8996. PRELIMINARY RESULTS ON K^+ INTERACTION AT HIGH ENERGY (200-350 MeV).
M.Grilli, L.Guerriero, M.Merlin, Z.O'Friel and G.A.Salandin.
Nuovo Cimento, Vol. 9, No. 2, 358-61 (July 16, 1958).

This work was done in emulsion. The charge-exchange scattering ratio is found to be 0.43 ± 0.10; the K–p cross-section is found to be 24_{-7}^{+8} millibarns, an increase over the low-energy value. One case of pion production was found. Using world data (3 cases) the pion production/inelastic event ratio is found to be ~ 0.006, rather higher than predicted by either theoretical model (see preceding abstract). R.H.W.Johnsto

539.1

8997. TABLES OF THE KINEMATICS OF THE PROCESSES, $K^- + p \rightarrow \Sigma^\pm + \pi^\mp$ AND $K + p \rightarrow K + p$. R.G.Glasser and G.A.Snow.
Nuovo Cimento Suppl., Vol. 8, No. 1, 1-122 (1958).

Values are tabulated of the laboratory kinetic energies and the laboratory angles of the final products for laboratory energies of th incident K-meson between 5 and 200 MeV, at intervals of 5 MeV, an for values of the centre-of-mass angle between the incident and final mesons from 0° to 180°, at intervals of 2.5°. E.J.Burg

539.12

8998. K^--MESON CAPTURES BY BOUND NEUTRONS.
F.C.Gilbert and R.S.White.
Phys. Rev., Vol. 109, No. 5, 1770-8 (March 1, 1958).

Experimental data is presented for K^--meson captures on bound neutrons and on two bound nucleons. K^--capture stars of only one prong and of only two prongs which are gray or black were analysed in an effort to understand the basic neutron and two-nucleo capture reactions. The same model that was used to explain the captures on bound protons was extended to apply to bound neutrons. The average Σ-hyperon nuclear potential is determined to be 35 ± 10 MeV attractive. This potential, coupled with the previously determined Coulomb potential of 10 ± 3 MeV and the momentum of the capture nucleon, causes an estimated 78, 78, 60, and 55% of the Σ-hyperons from the reactions $\Sigma^-\pi^+$, $\Sigma^-\pi^0$, $\Sigma^0\pi^-$, and $\Sigma^+\pi^-$, respectively, to be trapped in bound energy states. This high trapping probability leads to a high escape probability of 0.8 ± 0.1 for Σ-hyperons in unbound states and a corresponding Σ^+- or Σ^--hyperon charge-exchange cross-section of 11_{-6}^{+7} millibarns per neutron or proton respectively in the Ag nucleus. The proton-to-neutron K^--capture ratio is found to be 4_{-2}^{+4}. The fraction of K^- captures on neutrons that leads to the reaction $\Lambda^0\pi^-$ is $0.00_{-0.00}^{+0.13}$. The results indicate that most of the K^--mesons are captured in the interior of the nucleus. The numbers of multinucleon K^--captur which occur by the reactions Σ^+n, Σ^-p, and Σ^-n are estimated to be $1.3_{-0.9}^{+2.2}$, $0.0_{-0.0}^{+1.5}$ and $0.4_{-0.4}^{+1.0}$%, respectively. The data of this experiment are consistent with the reaction rates of $2 : 1 : 1\frac{1}{4} : 0 : \frac{1}{2} : \frac{1}{2} : 0$ for $\Sigma^-\pi^+$, $\Sigma^+\pi^-$, $\Sigma^0\pi^0$, $\Lambda^0\pi^0$, $\Sigma^-\pi^0$, $\Sigma^0\pi^-$, and $\Lambda^0\pi^-$, respectively. A.

539.12

8999. PHOTOPRODUCTION OF K MESONS AND THE INTRINSIC PARITIES OF THE STRANGE PARTICLES.
B.T.Feld and G.Costa.
Phys. Rev., Vol. 110, No. 4, 968-73 (May 15, 1958).

The general properties are examined near the threshold of the reactions γ + nucleon → hyperon + K meson, especially from the point of view of using these reactions to determine the intrinsic Y–K parity relative to that of the nucleon from which they are produced. The computations are based on the possibility that, unlike the pion case, there may be no enhancement of the interactio in some special state. Alternatively, departure of the observations from the predictions of such considerations will point out the importance of enhanced states. The approach is through a perturbation computation in which, however, a simple model is used of the Yukawa interaction in order to exhibit in explicit form the dependence of the reaction properties on the hyperon and K-meson moments and on the nature of their interaction. In general, it is

pointed out how observations on angular distributions must be combined with relative cross-sections and their energy dependence in order to draw unambiguous conclusions. A.

539.12

9000. PHOTOPRODUCTION OF K MESONS.
B.D.McDaniel, A.Silverman, R.R.Wilson and G.Cortellessa.
Phys. Rev. Letters, Vol. 1, No. 3, 109-11 (Aug. 1, 1958).

The reaction $\gamma + p \rightarrow K^+ + \Lambda^0$ was studied at a laboratory angle of 24.5°. The effect of $\gamma + p \rightarrow K^+ + \Sigma^0$ was detected and the results agree well with calculations. The differential cross-sections were measured for two photon energies, 980 and 1010 MeV, and the variation with energy from 935 to 1066 MeV was found for a c.m. angle of 85°. E.J.Burge

539.12

9001. ON THE CHARGE CONJUGATION OF BARYONS.
P.Budini, N.Dallaporta and L.Fonda.
Nuovo Cimento, Vol. 9, No. 2, 316-23 (July 16, 1958).

If one considers the baryon as composed by a bare spinor without charge or strangeness and the known meson fields (both π and K) one may investigate the behaviour of the Lagrangian describing this model under an operation which reverses the sign of charge and strangeness of the mesons without altering the bare baryon (boson conjugation B) and an operation which turns the bare baryon into its antiparticle without changing the meson fields (spinor conjugation S), the product of these two operations being the usual charge conjugation C. It is found, when one neglects mass differences between nucleon and hyperons, that the Lagrangian of this system is invariant for each of the three operations B, S and C separately. The same property is deduced also for the d'Espagnat–Prentki Lagrangian of an assembly of real nucleons, hyperons and mesons and for the interactions with the electromagnetic field of all these particles. Finally it is suggested that the mass difference between nucleon and Ξ could be due to an interaction term in the Lagrangian which should be invariant under charge conjugation but not under the B and S conjugations separately and a simple proposal for such a term is made. A.

539.12

9002. ANALYSIS OF THREE HYPERTRITON DECAYS.
K.Imaeda, M.Kazuno and T.Aiba.
Nuovo Cimento, Vol. 9, No. 2, 324-6 (July 16, 1958).

Data from analysis include times of flight of hypertriton (1.4, 1.4 and 2.2×10^{-11} sec) and Q-values (35.7, 34.7 and 34.5 MeV). E.J.Burge

539.12

9003. ELASTIC α ANGULAR DISTRIBUTIONS IN THE SHARP CUTOFF MODEL. J.S.Blair.
Phys. Rev., Vol. 108, No. 3, 827-36 (Nov. 1, 1957).

An analysis is made in terms of a semi-classical strong absorption model of all published angular distributions of intermediate energy alpha particles elastically scattered from heavy or medium weight nuclei as well as some examples of elastic proton and deuteron scattering. Moderately good agreement is found for radii obtained from different sets of data and also from analysis of fixed angle, variable energy experiments; there is some indication that the sharp cutoff radius increases as the bombarding energy is lowered to the Coulomb barrier. The connection between these results and optical model parameters is discussed. The best-fit critical angular momenta l' are found to be essentially equivalent to the largest angular momenta l_m such that the l_mth potential barrier is classically surmounted by the bombarding particle when the most recent optical model parameters are used to represent the nuclear potential. It is suggested that, when the penetration depth is small, the most important "effective" parameter is l_m. A.

539.12 : 539.14

9004. OPTICAL MODEL POTENTIAL AT THE NUCLEAR SURFACE FOR THE ELASTIC SCATTERING OF ALPHA PARTICLES.
G.Igo.
Phys. Rev. Letters, Vol. 1, No. 2, 72-4 (July 15, 1958).

The optical model fit for alpha-particle scattering being not unique, a more detailed analysis (including the fit of three angular distributions) is presented for a Saxon–Woods (Abstr. 9588/1954) form of nuclear potential and a radial charge distribution as proposed by Hill and Ford (Abstr. 8622/1954). The main conclusion is that alpha-particle scattering in the energy range 20 to 50 MeV is very sensitive to the surface of the nuclear potential, where the real part is attractive and of order 10 MeV, but yields no information about the central part of the potential. J.Lascoux

NUCLEUS

539.14

9005. QUANTUM MECHANICAL DESCRIPTION OF NUCLEAR COLLECTIVE MOTIONS. T.Tamura.
Fortschr. Phys., Vol. 6, No. 3, 109-68 (1958).

The paper contains a brief survey of the formulation of the Bohr–Mottelson model and an outline of the different methods of describing quantum-mechanically the nuclear surface oscillations. A section is devoted to a critical review of their shortcomings. The last part discusses the giant resonance in the photo-nuclear reactions. J.Lascoux

539.14

9006. SHELL-MODEL THEORY OF Pb^{206}.
W.W.True and K.W.Ford.
Phys. Rev., Vol. 109, No. 5, 1675-97 (March 1, 1958).

A detailed nuclear shell-model calculation of the energy levels and gamma-ray transition rates in Pb^{206} is carried through. For pure singlet two-body forces with the same effective range and strength as for the low-energy two-body system, energy level agreement is good — for 13 known levels, the mean discrepancy between theory and experiment is 0.057 MeV. For singlet forces 75% as strong as for the low-energy two-body system, plus weak coupling to collective vibration, the energy level agreement is somewhat better — the mean discrepancy between theory and experiment is 0.035 MeV per level. In the latter theory, the strength of collective motion is determined from the known Coulomb excitation cross-section in Pb^{206}. In either theory, the calculated transition rates are in qualitative accord with experiment, but quantitative agreement is lacking. Electric quadrupole transition rates are shown to be describable in terms of a neutron effective charge. The effective charge is about 1.15e and the same in Pb^{206} as in Pb^{207}. Other calculated quantities in good agreement with experiment are the relative cross-sections to final p-states in the $Pb^{206}(d,p)Pb^{207}$ reaction and the difference in binding energies of the last neutron in Pb^{206} and Pb^{207}. The results are shown to be insensitive to substantial amounts of triplet-odd force, either attractive or repulsive. A.

539.14 : 539.12

OPTICAL MODEL POTENTIAL AT THE NUCLEAR SURFACE FOR THE ELASTIC SCATTERING OF ALPHA PARTICLES. See Abstr. 9004

539.14

9007 NUCLEAR SYMMETRY ENERGY. H.P.Duerr.
Phys. Rev., Vol. 109, No. 1, 117-21 (Jan. 1, 1958).

On the basis of a phenomenological theory proposed in an earlier paper (Abstr. 7147/1956) the nuclear symmetry energy is re-calculated. The value obtained is smaller than the one given before, which was incorrect. A relativistic calculation of the energy with the radius parameter $r_0 = 1.07 \times 10^{-13}$ cm of the electron scattering experiments yields about the correct symmetry energy. Compensating uncertainties due to inaccuracy in r_0, corrections due to the exclusion principle, and a possible difference in the radius of proton and neutron distributions make an accurate comparison with the empirical symmetry energy meaningless. A.

539.14

9008. NUCLEAR POTENTIAL AND SYMMETRY ENERGY.
G.R.Satchler.
Phys. Rev., Vol. 109, No. 2, 429-33 (Jan. 15, 1958).

A quadratic dependence on momentum is assumed for the two-nucleon interaction energy in the independent-particle model, and is used in a study of the nuclear binding energy and symmetry energy. The corresponding optical potentials for elastic nucleon scattering are discussed. The semiempirical interaction used is compared with the two-body potentials commonly used in shell-model calculations. These are found to be inadequate. A.

539.14 : 539.18

TABLE OF BINDING ENERGIES FOR NEUTRONS, PROTONS AND ALPHA-PARTICLES. See Abstr. 8373

539.14

9009. EFFECTS OF THE DISTRIBUTION OF NUCLEAR MAGNETIZATION ON HYPERFINE STRUCTURE.
J.Eisinger and V.Jaccarino.
Rev. mod. Phys., Vol. 30, No. 2(I), 528-41 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). The paper is divided into two parts: (1) a review of the theoretical treatment of the effects of distributed nuclear

magnetism, and (2) a survey of the recent experimental results obtained by various techniques. A bibliography is included.

J.Lascoux

539.14 : 539.17

9010. SCATTERING OF HIGH-ENERGY ELECTRONS AND ELECTRIC CHARGE DISTRIBUTION IN THE NUCLEUS. J.Reignier.
Nuclear Phys., Vol. 7, No. 5, 526-51 (July [2], 1958). In French.

The phase-shift η_j of the partial wave j depends on the nuclear charge distribution only through the value at the edge of the nucleus of some function $\gamma_j(r)$, solution of a Riccati equation. Two methods are given for calculation of this function. These methods are quickly convergent and provide a very precise value of $\gamma_j(r)$ after one or two iterations only. The zero-order approximation (the same in both procedures) can be calculated very simply and is already quite close to the exact value. So far as this zero-order approximation is concerned the phase-shift η_j depends on the nuclear charge distribution only through the average value of some function $\mathcal{J}(\kappa r)$ weighted by the nuclear charge density. The sensitivity of the differential scattering cross-section to the details of the nuclear charge distribution is discussed. At not too high energies (less than about 100 MeV for heavy nuclei), the angular distribution of the scattered electrons depends mainly on the average values $< \mathcal{J}_j(\kappa r) >$. Finer details can be reached at higher energies but the static model of the nucleus becomes less founded. In the appendix, it is shown how the method may be applied to non-relativistic nuclear scattering. A.

539.14

9011. NEUTRON CROSS SECTIONS AND SCATTERING LENGTHS OF Cu^{63} AND Cu^{65}. D.T.Keating, W.J.Neidhardt and A.N.Goland.
Phys. Rev., Vol. 111, No. 1, 261-3 (July 1, 1958).

It is of interest to know whether the thermal-neutron scattering lengths of Cu^{63} or Cu^{65} are significantly different from natural copper. From measurements of the intensity of the (111) reflections of natural and isotopically enriched samples, the scattering lengths of Cu^{63}, Cu^{65}, and natural Cu are found to be $(+0.672 \pm 0.015) \times 10^{-12}$ cm, $(+1.109 \pm 0.019) \times 10^{-12}$ cm, and $(+0.790 \pm 0.023) \times 10^{-12}$ cm, respectively. The incoherent and absorption cross-sections for Cu^{63} and Cu^{65} are deduced from the values of the cross-sections of Cu^{63} and natural copper. The (spin) incoherent cross-sections of the two isotopes are zero within the accuracy of the data and the incoherent cross-section of natural copper is 0.4004 ± 0.1416 barn. The absorption cross-sections for Cu^{63}, Cu^{65}, and natural Cu are $(2.512 \pm 0.058)\lambda$, $(1.459 \pm 0.144)\lambda$, and $(2.1728 \pm 0.0182)\lambda$ barns, respectively, where λ is in angstroms. A.

539.14

9012. NUCLEAR RADII AS DETERMINED BY SCATTERING OF NEUTRONS. S.Fernbach.
Rev. mod. Phys., Vol. 30, No. 2(I), 414-18 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). From the low-energy data, the author concludes that the value of the nuclear radius is of the order of $(1.25 \pm 0.05)\ A^{1/3}\ 10^{-13}$ cm. The proposed form of the nuclear potential is: (1) for the real part, the Saxon–Woods form (Abstr. 9588/1954); (2) for the imaginary part, a Gaussian form centred about R_o; (3) a real spin-orbit potential of about 30 times the Thomas term. The higher energy data are estimated to be not good enough to determine the need for a spin-orbit potential.

J.Lascoux

539.14

9013. NUCLEAR DENSITY DISTRIBUTIONS FROM PROTON SCATTERING. A.E.Glassgold.
Rev. mod. Phys., Vol. 30, No. 2(I), 419-23 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). A brief summary is presented of the analyses of proton scattering from 10 to 300 MeV. Values for the radius and diffuseness of the spatial distribution of the proton potential are given; the corresponding parameters for the nuclear density are estimated about 15% smaller, from the very high energy data (proton of 1000 MeV). J.Lascoux

539.14

9014. NUCLEAR RADII BY LOW-ENERGY NEUTRON SCATTERING. K.K.Seth.
Rev. mod. Phys., Vol. 30, No. 2, 442-9 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). A survey of the results of the extreme compound nucleus model and of the optical model is presented. The necessity of considering nuclear deformations in the optical model appears in the data for the average reduced neutron width. The neutron scattering data seem to provide conclusive evidence for a large difference between nuclear charge (electron-scattering) and potentia radii. Proposed value for this latter is $r_o = 1.35 \pm 0.04$ fermi.

J.Lascoux

539.14

9015. MIRROR NUCLEI DETERMINATIONS OF NUCLEAR SIZE. O.Kofoed-Hansen.
Rev. mod. Phys., Vol. 30, No. 2(I), 449-56 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). The differences in Coulomb energies between adjacent pairs of mirror nuclei determine the value r_o of the charge density distribution. The author reviews the empirical results and discusses th different models used for interpretation. The proposed value is stated as $r_o = (1.28 \pm 0.05)\ 10^{-13}$ cm. J.Lascoux

539.14 : 539.18

9016. ISOTOPE SHIFT STUDIES OF NUCLEI. P.Brix and H.Kopfermann.
Rev. mod. Phys., Vol. 30, No. 2(I), 517-20 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). This is an up-to-date summary of the experimental results for the isotopic shifts in the optical spectra of heavy elements. Both the theoretical and experimental uncertainties are briefly discussed. J.Lascoux

539.14 : 530.145

NUCLEON CHARGE AND MAGNETIZATION. See Abstr. 8588

539.14

9017. 1.7 MeV STATE IN Be^9. D.W.Miller.
Phys. Rev., Vol. 109, No. 5, 1669-74 (March 1, 1958).

Evidence is presented concerning the 1.7 MeV state in Be^9 and its characteristics, which are currently in doubt because of the extreme weakness of the anomaly observed in charged-particle reactions. On the basis of this evidence, the state now appears to be well established, and its spin and parity are probably $\frac{1}{2}^+$ or $\frac{1}{2}^-$. The evidence in favour of the $\frac{1}{2}^+$ assignment, corresponding to an intermediate-coupling parameter a/K of ~ 2.75 for Be^9, comes from the final-state-interaction analysis in the present paper of the result of three different charged-particle reactions, from the agreement between the scattering length for neutrons on Be^8 resulting from this analysis and the predictions of Ford and Bohm, and from the continuity of a/K with mass number. In addition, experiments on the mirror nucleus B^9 by Marion et al. seem to be in disagreement with the existence of a $\frac{1}{2}^-$ state in this region. The evidence in favour of the $\frac{1}{2}^-$ assignment, corresponding to a/K ~ 1.5, comes from the static magnetic moment of Be^9 and the photodisintegration data of Connors and Miller. A.

539.14

9018. NUCLEAR LEVELS IN P^{30}, S^{33}, AND S^{34}. P.M.Endt and C.H.Paris.
Phys. Rev., Vol. 110, No. 1, 89-95 (April 1, 1958).

Targets of natural antimony sulphide were bombarded with deuterons accelerated by the M.I.T.–O.N.R. electrostatic generator to energies of 6.0 and 6.5 MeV. Charged reaction products, protons, alpha-particles, and elastically scattered deuterons, were observed at angles of 50, 90, and 130 degrees to the deuteron beam with a high-resolution, broad-range magnetic spectrograph. The ground-state Q-value of the $S^{32}(d,\alpha)P^{30}$ reaction was measured as 4.887 ± ±0.010 MeV. The previously reported first level in P^{30} appears to be a doublet with components at 0.680 and 0.708 MeV. On intensity grounds, an isobaric spin T = 1 is assigned to the lower level. Twenty-eight additional levels in P^{30} are observed in a region of excitation up to 5.8 MeV. The ground-state Q-value of the $S^{32}(d,p)S^{33}$ reaction is 6.413 ± 0.006 MeV, and one hundred four levels are observed up to an excitation energy of 8.0 MeV. Some levels stand out as single-particle states because of the high intensities of the corresponding proton groups. Six weak proton groups were assigned to the $S^{34}(d,p)S^{35}$ reaction. The ground-state Q-value is 4.757 ± ± 0.010 MeV. A.

539.14 : 539.166

9019. NUCLEAR RESONANCE FLUORESCENCE IN As^{75}. F.R.Metzger.
Phys. Rev., Vol. 110, No. 1, 123-7 (April 1, 1958).

When As^{75} is irradiated with the gamma-rays from a gaseous source of Se^{75}, strong resonance fluorescence from the 265 keV excited state is observed. The angular distribution of the resonance

radiation has the form $W(\theta) = 1 + (0.15 \pm 0.02)P_2(\cos\theta)$, indicating that the spin of the 265 keV level is larger than $\frac{1}{2}$. If one assumes a spin value of $\frac{3}{2}$, the measured self-absorption of the resonance fluorescence leads to a mean life of $(1.6 \pm 0.2) \times 10^{-11}$ sec for the 265 keV transition to the ground state of As^{75}. Resonance fluorescence from the 280 keV excited state was found to be at least one order of magnitude smaller than that from the 265 keV state. From this one concludes that the mean life of the 280 keV transition is longer than 10^{-10} sec. No resonance scattering from the 402 keV level was observed. On the basis of the source strength and of the geometry, the absence of an appreciable resonance effect establishes a lower limit of 10^{-10} sec for the mean life of the 402 keV state, and of 7×10^{-10} sec for the partial mean life of the 402 keV transition to the ground state. A.

539.14

9020. A CONTRIBUTION TO THE [ENERGY] LEVEL SCHEME OF PALLADIUM 105. R.Boedege.
Z. Phys., Vol. 151, No. 4, 483-6 (1958). In German.

The α-conversion coefficients for the two γ-transitions in Pd^{105} were measured as $\alpha(642\text{ keV}) = (1.3 \pm 0.2) \times 10^{-3}$ and $\alpha(436\text{ keV}) = (8.1 \pm 1) \times 10^{-3}$. A level scheme for this cascade is suggested. A.O.Stanesby

539.14 : 539.165/.166

EXCITED STATES OF Dy^{161}. See Abstr. 8293

539.14 : 539.166

THE ENERGY LEVELS OF Fe^{56}. See Abstr. 8301

539.14 : 539.166

RELATIVE TRANSITION PROBABILITIES IN CERTAIN EVEN NUCLEI. See Abstr. 8302

539.14 : 539.166

EXCITED STATES OF C^{14}. See Abstr. 8304

539.14 : 539.17

EXCITATION OF VIBRATIONAL AND ROTATIONAL STATES OF NUCLEI. See Abstr. 8321

539.14 : 539.17

$Na^{22, 23, 24}$ ENERGY LEVELS. See Abstr. 9051

539.14

9021. LIFETIMES OF THE 4.43 MeV EXCITED STATE OF C^{12} AND THE 4.46 MeV EXCITED STATE OF B^{11}.
V.K.Rasmussen, F.R.Metzger and C.P.Swann.
Phys. Rev., Vol. 110, No. 1, 154-60 (April 1, 1958).

Doppler-broadened 4.43 MeV γ-radiation from the reaction $N^{15}(p,\alpha)C^{12*}$ was used to measure the lifetimes of the 4.43 MeV level of C^{12} and the 4.46 MeV level of B^{11} by the nuclear resonance fluorescence technique. For C^{12}, the 90° and 126° scattering give mean lives of $(6.7^{+1.5}_{-0.4}) \times 10^{-14}$ sec and $(5.5^{+1.2}_{-0.4}) \times 10^{-14}$ sec, respectively. The self-absorption of the resonance radiation gives $(6.6 \pm 1.3) \times 10^{-14}$ sec. The adopted mean value is $(6.5 \pm 1.2) \times 10^{-14}$ sec. For B^{11}, the angular distribution of the resonance-scattered radiation is $1 + (0.1 \pm 0.1)P_2(\cos\theta)$, and the cross-section corresponds to $\tau = (1.02^{+0.23}_{-0.07}) \times 10^{-15}$ sec, if the spin of the excited states is 5/2. Interpretation of the self-absorption of the resonance radiation is uncertain because of lack of information as to the Debye temperature of B_4C. Values of 1250°K and 1860°K give $\tau = 1.33 \times 10^{-15}$ sec and $\tau = 1.14 \times 10^{-15}$ sec. The adopted mean value is $\tau = (1.17 \pm 0.17) \times 10^{-15}$ sec. A.

539.14

9022. NUCLEAR MAGNETIC RESONANCE OF SODIUM—AMMONIA SOLUTIONS. K.S.Pitzer.
J. chem. Phys., Vol. 29, No. 2, 453-4 (Aug., 1958).

The observation (Abstr. 8064/1957) that the Knight shift of the proton resonance is not detectable, while those of the sodium and nitrogen resonances are substantial, is explained if the unpaired electron wave-functions have nodes at the protons. It is shown that this can arise if the wave-functions are 3s-like about the nitrogen nuclei. E.F.W.Seymour

539.14 : 532.7

NUCLEAR MAGNETIC RELAXATION OF MOLECULES IN A LIQUID. See Abstr. 8615

539.14 : 518.5

9023. ISOMER SIMULATOR AND THE DISTORTION OF A DELAY ANALYZER. S.Akpinar.
Rev. sci. Instrum., Vol. 29, No. 4, 285-7 (April, 1958).

The decay statistics of a radioactive parent-short-lived daughter mixture is simulated by means of a circuit which superposes two random series. Daughter half-life and pulse composition can be varied between wide limits. The output distribution of a differential delay analyser for high input rates, containing disintegrations of short-lived isomeric states in the millisecond range is tested by using the simulator. A formula for such output distributions is given. A.

RADIOACTIVITY

539.16.08

9024. QUANTITATIVE DETERMINATION OF Sr^{90} WHEN MIXED WITH OTHER BETA-EMITTING ISOTOPES. G.Mayr.
Ricerca sci., Vol. 28, No. 7, 1469-72 (July, 1958). In Italian.

The concentration of Sr^{90} is determined by counting the density of β-tracks in a previously calibrated emulsion. The method is a sensitive one and can detect relatively small (< 10%) concentrations of Sr^{90} mixed with other β-emitters; results for a Sr^{90}/Y^{90} mixture are presented and application to Sr^{90}/Sr^{89} mixtures is proposed. J.W.Gardner

539.163

9025. NEW ISOTOPE, SULFUR-38.
D.R.Nethaway and A.A.Caretto,Jr.
Phys. Rev., Vol. 109, No. 2, 504-8 (Jan. 15, 1958).

A new isotope of sulphur, S^{38}, was produced by the $(\alpha,3p)$ reaction on Cl^{37}. It was found to have a half-life of 172 ± 1 minutes, and to decay by the emission of two beta-groups with end-point energies of 1.1 and 3.0 MeV. The 1.1 MeV beta was found to be in coincidence with a 1.88 MeV gamma-ray. No other gamma-rays were observed. The 3.0 MeV beta occurs in 5% of the disintegrations, and leads to the Cl^{38} ground state. The log (ft) values of the 1.1 and 3.0 MeV beta-groups are 5.0 and 8.2, respectively. A comparison is made of the $(\alpha,3p)$ reactions on Al^{27}, Cl^{37} and Cu^{65}. A.

539.163

9026. POSITRON DECAY OF Cu^{59} AND Cu^{61} AND ENERGY LEVELS IN Ni^{59} AND Ni^{61}. J.W.Butler and C.R.Gossett.
Phys. Rev., Vol. 109, No. 3, 863-71 (Feb. 1, 1958).

The energies and relative intensities of the gamma rays following the positron decay of Cu^{59} were determined. The energies are 0.343 ± 0.004, 0.463 ± 0.010, 0.872 ± 0.005, 1.305 ± 0.005, and 1.70 ± 0.01 MeV, with respective relative intensities of 16 ± 3, 15 ± 5, 29 ± 4, 36 ± 4, and 4 ± 2%. The half-life of Cu^{59} was measured to be 81.5 ± 0.5 seconds. The energies of ground-state transition gamma rays following the positron decay of Cu^{61} were measured as 0.070 ± 0.002, 0.282 ± 0.003, 0.659 ± 0.003, and 1.192 ± 0.005 MeV. The accumulated works of several authors are discussed and compared. A.

539.163 : 539.18

9027. TABLE OF ISOTOPES.
D.Strominger, J.M.Hollander and G.T.Seaborg.
Rev. mod. Phys., Vol. 30, No. 2(II), 585-904 (April, 1958).

A complete list of all the radioactive and stable isotopes of the elements, as recorded in the literature by February 1958. The data presented are: half-life, type of decay, class and identification, percent abundance, nuclear moments, energy of radiation, disintegration energy and schemes.

539.163

9028. THE GAMMA SPECTRUM OF Rh^{107}.
C.A.Mallmann, S.Mayo and S.J.Nassiff.
Rev. Mexicana Fís., Vol. 5, No. 4, 185-92 (Oct., 1956). In Spanish.

The lines were measured by means of a scintillation spectrometer with a NaI (T1) crystal. Lines were detected of the following energies and relative intensities: 305 ± 3 keV (100); 385 ± 5 (18 ± 2); 570 ± 5 (1.6 ± 0.5); 680 ± 5 (3 ± 0.5). Coincidence measurements showed that the lines at 305 and 385 keV occur in cascade. L.Pincherle

539.163.1

9029. LIFETIME OF THE 6.14 MeV 3^- STATE OF O^{16} BY A RECOIL METHOD. D.Kohler and H.H.Hilton.
Phys. Rev., Vol. 110, No. 5, 1094-102 (June 1, 1958).

The lifetime was measured by means of a recoil technique. The spatial distribution of decays of recoiling O^{16} nuclei, produced by the reaction $F^{19}(p,\alpha_1)O^{16*}$, was studied with a highly collimated γ-ray detector. Comparison with the corresponding distribution obtained when the O^{16} nuclei were stopped at the target surface by an evaporated metallic layer provided a means of determining the lifetime. A value for this half-life of $(8.6 \pm 4.0) \times 10^{-12}$ second (mean life, $\tau = (1.2 \pm 0.6) \times 10^{-11}$ sec) was found, consistent with previously

established limits. The measured value is compared with values predicted from various nuclear models. A.

539.164 : 539.165

9030. THE BRANCHING RATIO OF THORIUM C.
P.R.Evans and N.J.Freeman.
Proc. Phys. Soc., Vol. 72, Pt 2, 300-1 (Aug., 1958).

The intensity of the α-particle groups from Bi^{212}(ThC) and Po^{212}(ThC') was measured using a KI (Tl) crystal, discriminating against β emissions in the series. The branching ratio is found to be: $^{\alpha}Th(C)/^{\alpha}Th(C + C') = 0.359 \pm 0.002$ which disagrees with some earlier measurements by more than the experimental error, but agrees with one recent measurement.

A.E.I. Research Laboratory

539.165 : 539.166

9031. BETA–GAMMA CORRELATIONS WITH RESONANCE FLUORESCENCE. R.R.Lewis and R.B.Curtis.
Phys. Rev., Vol. 110, No. 4, 910-14 (May 15, 1958).

The study of beta–gamma angular correlations, with resonance fluorescence of the gamma-ray, is proposed as a means of obtaining important information on the beta-decay coupling constants. The effect is calculated for an allowed beta transition followed by a gamma transition of arbitrary multipolarity. As an example, detailed numerical results are given for Ne^{23}. A.

539.165 : 539.166.83

9032. POLARIZATION AND ANGULAR DISTRIBUTION OF X-RAY QUANTA EMITTED AFTER ELECTRON CAPTURE BY A NUCLEUS OR AFTER A CONVERSION TRANSITION. A.Z.Dolginov.
Zh. éksper. teor. Fiz., Vol. 34, No. 4, 931-41 (1958). In Russian.

The results obtained earlier (Abstr. 7348/1957) are extended to the case of K- or L-capture of any degree of forbiddenness taking into account non-conservation of parity. It is shown that observation of the correlation between the polarizations of X-ray quanta emitted by an atom after K- or L-capture and the direction of the nuclear spins or the polarization of the subsequent nuclear radiation may yield important data on β-interaction. The angular distribution of the X-ray quanta is anisotropic if capture occurs in the L_{III} shell. Some formulae are presented which permit one to determine the spins and parities of nuclear levels by observing the polarization of X-ray quanta after conversion transitions. A.

539.165

9033. THE POLARIZATION OF THE ELECTRONS FROM Co^{60}.
H.Bienlein, R.Fleischmann and H.Wegener.
Z. Phys., Vol. 150, No. 1, 80-6 (1958). In German.

The degree of polarization $P = Gv/c$ was measured, for the allowed GT transition of Co^{60}, at the electron velocity $v = 0.66$ c, by means of Mott scattering by Au, Ag and Al foils after deflection in the field of a spherical condenser. The result was $G = -0.96 \pm 0.06$. Sources of error are discussed. L.Pincherle

539.165.2

9034. SIMPLE APPROXIMATION FOR THE NON-UNIQUE FIRST FORBIDDEN TRANSITION. T.Kotani and M.Ross.
Phys. Rev. Letters, Vol. 1, No. 4, 140-2 (Aug. 15, 1958).

The approximation which retains only the leading terms of the transition probability in powers of the nuclear radius is examined. Its consequences for other observables, such as β–γ directional correlation and longitudinal β-polarization, are discussed.

R.J.N.Phillips

539.165.2

9035. THE TYPE OF GAMOW–TELLER EXCHANGE INTERACTION IN THE DECAY OF Li^8.
K.H.Lauterjung, B.Schimmer and H.Maier-Leibnitz.
Z. Phys., Vol. 150, No. 5, 657-9 (1958). In German.

The electron–antineutron angular correlation in this reaction was investigated in an attempt to decide the existence of tensor or axial vector coupling in the Gamow–Teller decay; the experimental results indicate a preponderance of axial vector coupling.

A.O.Stanesby

539.166 : 539.17

9036. YIELDS, ANGULAR DISTRIBUTIONS, AND POLARIZATION OF GAMMA RAYS FROM COULOMB EXCITATION.
F.K.McGowan and P.H.Stelson.
Phys. Rev., Vol. 109, No. 3, 901-16 (Feb. 1, 1958).

The yields of gamma-rays resulting from Coulomb excitation were measured for Tl^{208}, Tl^{203}, Au^{197}, Ir^{193} Ir^{191}, Re^{187}, Re^{185}, W^{183} Ta^{181}, Cd^{113}, Cd^{111}, Ag^{109}, Ag^{107}, Rh^{103}, Mo^{96}, Os^{188}, Os^{190}, Os^{189}, Os^{188}, W^{186}, W^{184}, and W^{182}. Angular distributions of the gamma-radiation from the nuclei Tl^{208}, Tl^{203}, Au^{197}, Ir^{193}, Ir^{191}, Re^{187}, Re^{185}, Ta^{181}, Cd^{113}, Cd^{111}, Ag^{109}, Ag^{107}, Rh^{103}, and Mo^{96} were measured with respect to the incident proton beam on thick targets. The linear polarization of gamma-rays following Coulomb excitation was studied. A polarimeter based on the Compton scattering mechanism was constructed and its effectiveness determined by measurements of the known polarization of gamma-rays from excitation of 2+ levels in even-even nuclei. Polarization-direction measurements of several transitions in odd-mass nuclei have resolved the ambiguity either in the value of $(E2/M1)^{1/2}$ or in the spin of the excited state deduced from the angular distributions. Reduced transition probabilities for E2 and M1 transitions are obtained. In some instances these quantities are compared to the predictions of the collective model of the nucleus. A.

539.166

9037. DIRECTIONAL CORRELATION OF THE GAMMA RAYS OF Se^{76}. E.G.Funk,Jr and M.L.Wiedenbeck.
Phys. Rev., Vol. 109, No. 3, 922-5 (Feb. 1, 1958).

Measurements were made on the 0.65-0.55, 2.05-0.55, and 1.40-1.20 MeV gamma-ray cascades in Se^{76} following the beta decay of 26.8 hr As^{76}. The energy levels of Se^{76} were found to have spins 0+, 2+, 2+, and 3+ in order of increasing energy. The 0.55 and 1.20 MeV gamma rays are pure electric quadrupole; the 0.65 MeV gamma ray almost pure electric quadrupole (< 1% dipole); the 1.40 MeV gamma ray pure magnetic dipole; and the 2.05 MeV gamma ray a mixture of 95% electric quadrupole and 5% magnetic dipole. A possible explanation of the decay scheme in terms of vibrational levels is presented. A.

539.166

9038. ON THE MEASUREMENT OF ANGULAR CORRELATIONS IN THE γ-SPECTRUM OF Tm^{169}. U.Cappeller and R.Klingelhöfer.
Z. Phys., Vol. 150, No. 3, 375-88 (1958). In German.

A check of the level scheme of Tm^{169} was made by measuring the angular correlation between the 199/110 and 178/131 keV γ-ray cascades, using two single-channel scintillation spectrometers in coincidence. The measurements confirm angular momenta and multipole orders already proposed. A.O.Stanesby

539.166

9039. HIGH-ENERGY γ-TRANSITIONS OF LOW INTENSITY IN THE DECAY $^{131}_{83}Bi^{214}(RaC) \beta^- {}^{130}_{84}Po^{214}(RaC')^*$. U.Hauser.
Z. Phys., Vol. 150, No. 5, 593-8 (1958). In German.

High energy γ-decays of Po^{214}(RaC') were sought, using a deuterium-filled proportional counter as γ-spectrometer. Five weak γ-lines were found, three of which correspond to direct γ-transitions to the ground state from levels which are required from knowledge regarding the α-decay of Po^{214}(RaC'). P.K.Kabir

539.166

9040. NUCLEAR RESONANCE FLUORESCENCE IN Ir^{191} FOR GAMMA RAYS. R.M.Mössbauer.
Z. Phys., Vol. 151, No. 2, 124-43 (1958). In German.

The effective cross-section for resonance absorption of 129 keV γ-rays from the decay of Os^{191} was measured as a function of the temperature of source and absorber in the range 90-370°K. The lifetime of the 129 keV levels in Ir^{191} is $(3.6^{+1.9}_{-0.8}) \times 10^{-10}$ sec. For low temperatures the cross-section shows a strong dependence on crystal binding and the theory of Lamb (Abstr. 1374/1939) for neutron absorption is adapted to the present case. J.M.Hough

539.166 : 539.17

γ-RAYS EMITTED IN THE FISSION OF U^{235}. See Abstr. 8358

539.166.07

9041. EXPERIMENTAL GAMMA-RAY COLLIMATOR SENSITIVITY PATTERNS. F.M.Tomnovec and R.L.Mather.
J. appl. Phys., Vol. 28, No. 10, 1208-11 (Oct., 1957).

The spatial sensitivity pattern of a gamma-ray collimator and NaI scintillation detector was explored with small radiation sources of three gamma-ray energies (0.145, 1.12, 1.59 MeV). The collimator used was a cylindrical hole of $\frac{1}{2}$ in. diameter through 8 in. of lead. The results are compared with calculated patterns. The effects of penetration of the collimator edges are clearly shown. A.

539.166.07 : 530.19 : 539.12

GAMMA-RAY COLLIMATOR PENETRATION AND SCATTERING EFFECTS. See Abstr. 8962

539.166.83

9042. NUCLEAR STRUCTURE EFFECTS IN INTERNAL CONVERSION. T.A.Green and M.E.Rose.
Phys. Rev., Vol. 110, No. 1, 105-22 (April 1, 1958).

The problem of the influence of nuclear structure on the

calculation of conversion coefficients is discussed and a distinction is made between those effects (static) which are essentially calculable without a detailed nuclear model and the effects (dynamic) for which such a model is mandatory. The theory of the conversion process is developed in such a way as to provide formulae wherein both types of effects are exhibited. No attempt is made to provide specific numerical results for the dynamic effects but instead a framework is provided within which the internal conversion predictions of any nuclear model can be readily tested. In order to do this it is necessary to know not merely the conversion coefficient but the matrix elements for the separate final states as complex numbers. This information, which is available at present for only the K shell, is utilized to provide numerical results for the K shell and for several values of transition energy and atomic number. Electric and magnetic 2^L-pole transitions with $1 \leq L \leq 5$ are considered. A.

539.166.83

9043. THE INTERNAL CONVERSION RATIO FOR THE 40 keV TRANSITION OF Tl^{206}. I.Y.Krause.
Z. Phys., Vol. 151, No. 2, 210-19 (1958). In German.

The intensity of the 40 keV γ-radiation was measured relative to the number of α-particles in the decay of ThC, using a scintillation spectrometer; the internal conversion ratio $\alpha = 22.8 \pm 1.0$, and $\alpha_L = 18.2 \pm 1.0$. A.O.Stanesby

539.167.3 : 541.124

9044. RESIDUAL CONCENTRATION OF A DAUGHTER SUBSTANCE REMOVED BY A BIMOLECULAR REACTION. J.Rothstein.
J. chem. Phys., Vol. 28, No. 1, 153-63 (Jan., 1958).

Consider an initial concentration N_0 of a parent substance transforming monomolecularly into a daughter substance. The differential equation giving the concentration n of the latter subject to the condition that the daughter substance is removed by a bimolecular reaction is reduced to the form $y' = e^{-x} - y^2$. The solution is given in graphical and tabular form, and several approximations analysed. The measurement of decay constants in terms of reaction constants and vice versa is discussed. Possible applications to studies of chemical kinetics, lattice defects, order–disorder transformations in solids, electronic processes in semiconductors and phosphors, recombination of ions in liquids and gases, and tracer studies in vitro and in vivo are mentioned. A.

NUCLEAR REACTIONS

539.17

9045. R-MATRIX THEORY OF NUCLEAR REACTIONS.
A.M.Lane and R.G.Thomas.
Rev. mod. Phys., Vol. 30, No. 2, 257-353 (April, 1958).

This is a very detailed exposition of the theory. Among the unusual material presented are: (1) a thorough discussion of the elastic scattering by a potential and of the mathematical properties of Wigner R-functions (causality condition); (2) three different derivations of the R-matrix which are collected together. The treatment of the collision matrix is related [although in a very "indirect" way] to the Kapurs–Peierls expansion, and to recent work in this direction. The last chapters give a full account of all the applications of the R-matrix theory made up to now. A great care is taken to see how the R-matrix theory can be made to describe the direct interaction mechanism. J.Lascoux

539.17

NUCLEAR REACTIONS DUE TO COSMIC RAYS. See also under "Cosmic rays". Decimal classification 537.591.8

539.17

9046. PRODUCTION OF He^6 BY HIGH-ENERGY PROTONS.
F.S.Rowland and R.L.Wolfgang.
Phys. Rev., Vol. 110, No. 1, 175-7 (April 1, 1958).

Excitation functions were obtained for the production of He^6 in the interactions of high-energy protons with various targets. The cross-sections rise with increasing energy and increasing Z, varying between 0.5 millibarns for C at 1.0 BeV and 29 millibarns for Pb at 3.0 BeV. A.

539.17

9047. PRODUCTION OF F^{18} AND Na^{24} IN IRRADIATIONS OF VARIOUS TARGETS WITH PROTONS BETWEEN 1 AND 6 BeV.
A.A.Caretto, J.Hudis and G.Friedlander.
Phys. Rev., Vol. 110, No. 5, 1130-3 (June 1, 1958).

Cross-sections are reported for the formation of Na^{24} and F^{18} in the interaction of Cu, Ag, Ta, Au, Pb, and U with protons of several energies between 1 and 6 BeV. The cross-sections all increase with increasing energy. At each energy the cross-sections go through a minimum when plotted against target mass number. The data are interpreted in terms of a spallation mechanism for Cu and Ag targets, with some contribution from fission especially in the case of Ag, and in terms of a fragmentation process for the heavy-element targets. A.

539.17

9048. ABSOLUTE ASSAY AND STUDY OF SHORT-LIVED RADIONUCLIDES BY A RECOIL TECHNIQUE.
F.S.Rowland and R.L.Wolfgang.
Rev. sci. Instrum., Vol. 29, No. 3, 210-14 (March, 1958).

A new type of accelerator target was used to determine the yield of He^6 from high-energy nuclear reactions. In this target the nuclear recoil of the product isotope separates it from the target material and carries it into a "catcher" gas which is then swept into a counter. Because of the design principle employed in this target, the data can be translated directly into absolute cross-sections without explicit knowledge of the recoil properties of the product. This type of system may also prove useful in the determination of (1) the relative stopping powers of gases; (2) the rate of thermal diffusion of product species through the target material; and (3) the chemical properties of short-lived species of large kinetic energy. A.

539.17

9049. INVESTIGATION OF (p, pxn) REACTIONS ON IODINE.
M.Ya.Kuznetsova, V.N.Mekhedov and V.A.Khalkin.
Zh. éksper. teor. Fiz., Vol. 34, No. 5, 1096-100 (1958). In Russian.

Formation of the radioactive isotopes I^{126}, I^{125}, I^{124}, I^{123}, I^{121} and I^{120} from I^{127} was investigated by a radiochemical method, the isotopes being produced by 100, 170, 300, 480 and 660 MeV protons. The experimental data are analysed and compared with the results of investigation of similar reactions on other elements. The fraction of K-capture in I^{126}, I^{124}, I^{121} and I^{120} was determined. A.

539.17 : 539.166

COULOMB EXCITATION BY PROTONS. See Abstr. 9036

539.17

9050. MEASUREMENT OF THE ENERGY SPECTRUM OF PROTONS EMITTED FROM THE FUSION REACTION IN SCEPTRE III.
W.M.Jones, A.C.L.Barnard, S.E.Hunt and D.R.Chick.
Nature (London), Vol. 182, 216-17 (July 26, 1958).

Measurements of the proton energy from the reaction $D(d,p)H^3$ are reported at angles of observation of 30^0, 90^0 and 150^0 to the positive ion current in a toroidal discharge tube. The energy at 90^0 is 3.03 ± 0.02 MeV, indicating that these protons originate from the (d–d) fusion reaction, the majority being emitted from the centre of the discharge tube. At 30^0 the energy is 3.10 ± 0.04 and at 150^0 it is 2.92 ± 0.04. This difference indicates that the majority of protons observed originate from fusion between deuterons whose centre of mass has a velocity component in the direction of positive gas current flow. A.E.I. Research Laboratory

539.17 : 539.14

9051. ANGULAR DISTRIBUTIONS FROM DEUTERON-INDUCED REACTIONS IN SODIUM. W.F.Vogelsang and J.N.McGruer.
Phys. Rev., Vol. 109, No. 5, 1663-8 (March 1, 1958).

Angular distributions and absolute cross-section were obtained for a group of reactions induced by 14.8 MeV deuteron bombardment of Na^{23}. The ground state and the 1.341 MeV state of the $Na^{23}(d,p)Na^{24}$ reaction were fitted with Butler curves of $l_n = 2$ and 0 respectively. The angular distributions of seven levels of the reaction $Na^{23}(d,d')Na^{23}$ were obtained. The Q-values of these levels were measured to be −0.441, −2.073, −2.400, −2.689, −2.997, −3.689, −3.925 and −4.457 MeV all with an uncertainty of ±0.040 MeV. The ground state and the first three excited states of Na^{22} were observed by the reaction $Na^{23}(d,t)Na^{22}$. It was possible to fit the angular distributions to all the Na^{22} states with $l_n = 2$. The Q-value of the $Na^{23}(d,t)Na^{22}$ ground state was measured to be $Q = -6.211 \pm 0.040$ MeV. A.

539.17

9052. POLARIZATION OF PROTONS FROM (d,p) REACTIONS ON C^{12} AND Si^{28}. A.C.Juveland and W.Jentschke.
Phys. Rev., Vol. 110, No. 2, 456-61 (April 15, 1958).

The polarization of five proton groups from the reactions $C^{12}(d,p)C^{13}$ and $Si^{28}(d,p)Si^{29}$ was measured at several proton angles at a deuteron energy of 11.9 MeV. In the case of the carbon ground-state group, the sign of the polarization agrees with the measure-

ment of Hillman using 4.05 MeV deuterons and with the calculations of Cheston for 3.29 MeV deuterons. The largest value of the polarization was measured for the carbon ground-state group, with the value -0.49 ± 0.13 at a proton angle of 69.0°. At small proton angles there is for the $l_n = 1$ proton groups a consistent correlation between the sign of the polarization and the relative orientation of the spin of the captured neutron and its orbital angular momentum. A.

539.17

9053. ENERGY SPECTRUM OF ALPHA PARTICLES FROM $Li^7 + d$ AT $E_d = 1.0$ MeV. G.Weber.
Phys. Rev., Vol. 110, No. 2, 529-31 (April 15, 1958).

The high-energy part of the alpha spectrum was measured at $E_d = 1.0$ MeV and $\theta = 90°$. For the Li (d,α)He^5 (ground state) reaction, a Q value of 14.11 ± 0.08 MeV is obtained. The spectrum yields level parameters for the ground state of He^5 which are consistent with those known from n–α scattering data. No definite evidence for an α group corresponding to an excited state of He^5 was found. A.

539.17

9054. THE YIELDS OF (d,2n) REACTIONS IN THE CONTINUOUS REGION. O.Hittmair.
Z. Phys., Vol. 150, No. 5, 648-52 (1958). In German.

The reaction is considered as occurring in three possible ways: absorption of the deuteron and evaporation of two neutrons; a (d,n) stripping reaction followed by evaporation of one neutron; and direct (p,n) exchange at the surface of the initial nucleus. A.O.Stanesby

539.17 : 539.217

9055. THE FORMATION OF "SELF-TARGETS" FOR THE NUCLEAR REACTION D(d,n)He^3 AND ITS CONNECTION WITH THE PROBLEM OF HYDROGEN DIFFUSION IN METALS. K.Fiebiger.
Z. angew. Phys., Vol. 9, No. 5, 213-23 (May, 1957). In German.

Some of the deuterons fired by an accelerator into a metal target may remain in the target, providing a "self-target" for the (d,d) reaction. The concentration of deuterium in the metal is possible only to a limited extent so that the neutron yield of such a self-target must exhibit a saturation. To gain a general understanding of the function of self-targets, the magnitude of the saturation neutron yield is experimentally investigated and its dependence on the nature of the metal and other relevant parameters (temperature, beam current density), as well as the temporal development of the saturation process. This yields interesting information regarding the velocity of diffusion of hydrogen in metals. P.K.Kabir

539.17 : 539.14

SCATTERING OF ELECTRONS AND ELECTRIC CHARGE DISTRIBUTION IN THE NUCLEUS. See Abstr. 9010

539.17

9056. PHOTOPROTONS FROM NITROGEN.
G.Cortini, C.Milone, R.Rinzivillo and C.Tribuno.
Nuovo Cimento, Vol. 9, No. 1, 188-91 (July 1, 1958).

Cross-sections are estimated making use of results from irradiations of a nitrogen gas target with 18, 23 and 30 MeV γ-rays from the Turin betatron. Emitted protons were detected at 90° by photographic emulsions. R.H.W.Johnston

539.17

9057. EJECTION OF PHOTOPROTONS FROM LIGHT ELEMENTS BY 45-110 MeV BREMSSTRAHLUNG. C.Whitehead, W.R.McMurray, M.J.Aitken, N.Middlemas and C.H.Collie.
Phys. Rev., Vol. 110, No. 4, 941-53 (May 15, 1958).

Absolute differential cross-sections for the production of photoprotons from carbon, lithium, and beryllium were measured using the Oxford 110 MeV synchrotron. A proton telescope was used to select protons of energy 37, 47, 55, 63 and 78 MeV, using bremsstrahlung beams with peak energies from 40 to 110 MeV. Measurements were taken at angles of 36°, 51°, 71°, 90°, 119° and 129°. Comparison of the carbon results with the calculations of Dedrick (Abstr. 664/1956) indicate that the principal contributions to the cross-sections arise from quasi-deuteron interactions. Some evidence is presented that other processes occur near threshold. Measurements of neutron–proton coincidences were made showing that this direct manifestation of the quasi-deuteron interaction occurs at these energies. A.

539.17

9058. FORMATION OF A PHOTO-STAR AND A FAST PROTON OR AN ANTIPROTON. A.S.Bushev and Yu.A.Vdovin.
Zh. éksper. teor. Fiz., Vol. 34, No. 6, 1652-3 (1958). In Russian.

The following problem is considered. A high energy γ-quantum forms a proton–antiproton pair. One of the two particles is absorbed and produces a "nuclear star" while the other carries off an energy which is of the order of the total energy of the star. The ultrarelativistic region only is discussed and the strong interaction between the proton (or the antiproton) and the nucleus is taken into account by means of the optical model. S.Chomet

539.17 : 539.12

9059. ANGULAR AND ENERGY DISTRIBUTIONS OF THE PHOTO-PROTONS FROM THE PROCESS $A^{40}(\gamma,p)Cl^{39}$.
F.Gudden and J.Eichler.
Z. Phys., Vol. 150, No. 4, 436-46 (1958). In German.

These were investigated in the Wilson chamber using γ-radiation from a 15 MeV betatron. The energy distribution had maxima at 0.71 and 0.84 MeV and the angular distribution was almost pure $\sin^2\theta$. A.O.Stanesby

539.17 : 537.591.8

COSMIC-RAY PHOTON PRODUCTION OF MESONS AND HYPERFRAGMENTS. See Abstr. 8855

539.17 : 541.15

CHEMICAL EFFECTS OF PHOTONUCLEAR REACTIONS IN THE PROPYL BROMIDES. See Abstr. 9170

539.17 : 539.14

9060. RESONANCE SCATTERING OF SLOW NEUTRONS ON INDIUM. J.A.Moore.
Phys. Rev., Vol. 109, No. 2, 417-24 (Jan. 15, 1958).

The scattering of slow neutrons by indium was observed by using a crystal spectrometer as a monoenergetic neutron source. Thin scattering samples were placed in the neutron beam with the plane of the samples at a small angle to the incident beam. The samples therefore appeared thick for the transmitted neutrons but thin for neutrons scattered at right angles to the direction of the incident beam. A measurement of the scattered and the transmitted neutrons gives σ_s/σ_t. The total cross-section σ_t was also measured in the energy range from 0.3 to 11 eV and the value of σ_s then computed. Both the total cross-section and σ_s/σ_t results could be well matched to the Breit–Wigner formulae from 0.3 to 3 eV with the same set of parameters, assuming that the spin of the compound state in In^{116} for the 1.456 eV level was 5. No determination of the spin state of the compound nucleus could be made for higher levels. A.

539.17 : 539.14

9061. BACK-ANGLE ELASTIC SCATTERING OF 14.6 MeV NEUTRONS.
J.D.Anderson, C.C.Gardner, M.P.Nakada and C.Wong.
Phys. Rev., Vol. 110, No. 1, 160-3 (April 1, 1958).

Differential elastic scattering cross-sections were obtained for 14.6 MeV neutrons on Fe, Ag, Cd, Sn, and Pb in 5° steps from 90° to 167°. Time-of-flight techniques and one-meter radius rings were used to reduce background, obtain reasonable counting rates, and preserve angular resolution. Optical model calculations by Bjorklund and Fernback (Abstr. 5312/1956) indicate that a spin–orbit coupling term is needed to fit the data. A.

539.17

9062. NUCLEAR LEVELS EXCITED BY INELASTIC NEUTRON SCATTERING. F.I.Boley, E.H.Thorndike and A.T.Moffet.
Phys. Rev., Vol. 110, No. 4, 915-22 (May 15, 1958).

Gamma-ray, neutron, and gamma–gamma coincidence spectra were obtained from inelastic interactions of 2.48 MeV neutrons with P^{31}, Mn^{55}, Co^{59}, As^{75}, Nb^{93} and Bi^{209}. The following gamma-rays were observed: Co^{59} 2.11 ± 0.05, 0.698 ± 0.015, 0.559 ± 0.022, 0.132 ± 0.010 MeV; As^{75} 1.81 ± 0.04, 1.61 ± 0.04, 1.32 ± 0.04 MeV; Nb^{93} 2.11 ± 0.08, 1.94 ± 0.07, 1.52 ± 0.04, 0.345 ± 0.017 MeV. Evidence was found for the existence of a 1.56 ± 0.03 MeV level in Mn^{55} and possibly a 1.02 ± 0.05 MeV level in As^{75}. The following previously unreported coincidences were observed: Co^{59} 0.132 – 2.11 MeV; and As^{75} 0.578 – 0.136 MeV. A.

539.17

9063. TOTAL CROSS SECTIONS FOR 190 MeV POSITIVELY CHARGED K MESONS IN COMPLEX NUCLEI.
L.T.Kerth, T.F.Kycia and L. van Rossum.
Phys. Rev., Vol. 109, No. 5, 1784-91 (March 1, 1958).

The total attenuation cross-section and the differential-scattering cross-section in one angular interval were measured for K^+-mesons of 190 MeV kinetic energy. The targets were carbon, aluminium, copper, silver, and lead. The cross-sections were analysed in terms of the optical model to determine the parameters

of the complex square-well potential. The average real potential was found to be 24.4 ± 2.3 MeV. The mean free path in nuclear matter was determined to be consistent with an average K^+—nucleon scattering cross-section of about 10 millibarns. Some evidence was found for an increase of the mean free path in nuclear matter with Z. A.

539.17

9064. SEMIEMPIRICAL CORRELATION OF FISSION YIELD AND KINETIC ENERGY DISTRIBUTIONS. A.G.W.Cameron.
Rev. mod. Phys., Vol. 30, No. 2(I), 553-7 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr. 6217 (1958). Describes and discusses a new fission model (based on the Wigner—Eisenbud reaction formalism) in which the radius of separation of the fragments depends on the fission channel. This radius of separation is larger for asymmetric than for symmetric fission, and increases with the excitation energy of the fragments. An improved level density formula is also used. R.J.N.Phillips

539.17

9065. CORRELATION OF THE COMPETITION BETWEEN NEUTRON EMISSION AND FISSION. J.R.Huizenga.
Phys. Rev., Vol. 109, No. 2, 484-6 (Jan. 15, 1958).

Values of the ratio of the fission cross-section divided by the total cross-section for 3 MeV neutrons are correlated with the fission parameter Z^2/A. For compound nuclei excited 8 to 12 MeV above their ground states, the fission width Γ_f derived from neutron- and gamma-induced fission data increases linearly with Z^2/A. The quantity Γ_f/Γ_n is independent of energy for a particular nuclide excited between 8 and 12 MeV. A.

539.17

9066. VOID-INDUCED POWER DISTORTION IN BOILING-WATER REACTORS. J.W.Weil.
Nucleonics, Vol. 16, No. 6, 90, 92-3 (June, 1958).

The presence of high bubble concentrations in high-flux regions of high power boiling-water-reactors changes the flux distribution. This in turn alters the void distribution. The changes in power distribution can be large in reactors with large cores. An iterative procedure for the solution of the problem in two dimensions has been programmed for a digital computer. R.D.Smith

539.17

9067. WATER-CHANNEL PEAKING FACTORS. R.W.Deutsch.
Nucleonics, Vol. 16, No. 6, 95-9 (June, 1958).

Water channels in the core of metal-fuelled light water reactors cause power peaking at the channel boundaries. A method of estimating the peak to average flux is developed by applying diffusion theory to infinite plane channels. Approximate expressions are deduced for finite geometry that are in good agreement with experimental measurements. Optimum geometries for minimum peaking in actual lattices are discussed. R.D.Smith

539.17 : 536.483

CRYOSTAT FOR REACTOR IRRADIATION. See Abstr. 8735

ATOMS

539.18

9068. CONTRIBUTION TO THE STUDY OF THE PROCESSES OF RADIATIVE AND NON-RADIATIVE TRANSITIONS IN THE ELECTRON CLOUD. CALCULATION OF RELATIVE INTENSITIES AND RADIATIVE WIDTHS OF SPECTRAL LINES, AND SEMI-DIRECT DETERMINATION OF THE FLUORESCENCE YIELD FOR K AND L_I, L_{II}, L_{III} LEVELS OF CERTAIN HEAVY ATOMS (Z = 74, 78, 82, 83). W.Laskar.
Ann. Phys. (Paris), Sér. 13, Vol. 3, No. 3-4, 258-318 (March-April, 1958). In French.

Theoretical thesis giving in detail the methods and results of calculations briefly reported in Abstr. 7706 (1953), 564 (1956). J.Hawgood

539.18

9069. ZERO FIELD SPLITTINGS IN ATOMIC NITROGEN AT 4.2°K. T.Cole and H.M.McConnell.
J. chem. Phys., Vol. 29, No. 2, 451 (Aug., 1958).

Further work on the electron spin resonance of atomic nitrogen trapped in a matrix of molecular nitrogen at 4.2°K, with a more sensitive spectrometer, has resolved a fine structure of the $^4S_{3/2}$ ground state, due to a zero field splitting. The splitting parameter D is 31 ± 6 Mc/s, when the term describing this effect in the spin Hamiltonian is $D[S_\lambda^2 - \frac{1}{3}S(S+1)]$. J.M.Baker

539.18

9070. IMPROVED SIMPLE ANALYTICAL WAVE FUNCTIONS FOR ATOMS. A.F.Saturno and R.G.Parr.
J. chem. Phys., Vol. 29, No. 3, 490-3 (Sept., 1958).

Approximate wave-functions for the ground states of He, Be, Ne, and Na^+ are constructed which are antisymmetrized products of single Slater orbitals of nonintegral principal quantum numbers n_s, n_s', n_p and variable orbital exponents, ζ_s, ζ_s', ζ_p. Best values for the several parameters n and ζ are determined by the variational method, and the corresponding energies are computed. Significant improvements over the usual integral-n approximations are found; for Na^+ there is obtained an energy −161.44 a.u. compared with the integral-n result −160.94 a.u. and the Hartree—Fock value −161.88 a.u. The ground states of the two-electron ions H^- through NaX are similarly treated, and the diamagnetic susceptibilities of He, Be, Ne and Na^+ are computed theoretically and compared with observed and other theoretical values. A.

539.18

9071. NEW METASTABLE STATE OF MERCURY. W.Lichten.
Phys. Rev., Vol. 109, No. 4, 1191-2 (Feb. 15, 1958).

A state of Hg with an excitation potential of 9 V was found to be metastable. It is most likely the $^3D_3$ state of the configuration $(5d)^9(6s)^2(6p)$. It is possible that other members of this configuration also are long-lived. The use of alkali metals as detectors for metastable atoms is discussed. A.

539.18

9072. ANTISHIELDING OF NUCLEAR QUADRUPOLE MOMENTS IN HEAVY IONS. E.G.Wikner and T.P.Das.
Phys. Rev., Vol. 109, No. 2, 360-8 (Jan. 15, 1958).

Sternheimer antishielding factors, γ_∞ (Abstr. 4796/1954), are calculated for a number of heavy ions (K^+, Ga^{+++}, Cl^-, Cu^+, Rb^+, Cs^+, Br^- and I^-), by using a variational procedure. Since there is more than one p-shell and sometimes more than one d-shell for these ions, an important modification of the original variational procedure was needed before it could be extended to these heavier ones. In the case of Cl^-, Rb^+, and Cs^+, the authors were able to compare their values with those obtained earlier by Sternheimer (Abstr. 5292/1956). A good agreement was found for Cl^-, but the present authors' values for Rb^+ and Cs^+ were somewhat lower. The reason for this discrepancy is discussed, and it is concluded that for heavy ions, Sternheimer's procedure is more accurate than the variational procedure. The calculated values of γ_∞ are used to interpret two sets of data: (1) nuclear quadrupole coupling constants in a number of ionic diatomic molecules and ionic crystals; and (2) relaxation times times in nuclear magnetic resonance experiments in some ionic crystals. A.

539.18 : 530.145

CONSOLIDATED VARIATION PERTURBATION THEORY. See Abstr. 8596

539.18 : 539.12

DECAY OF MUONS IN MESIC ATOMS. See Abstr. 8984

539.18 : 541.135

9073. ISOTOPE ENRICHMENT IN A CONTINUOUS FEED PROCESS. A.E.Bainbridge and A.T.Wilson; S.Tolansky.
Nature (London), Vol. 181, 1729-30, 1730 (June 21, 1958).

Bainbridge and Wilson establish theoretically that one cannot expect an important isotope enrichment in electrolysis (and such like), in cases which embody continuous feed. It is shown that the greatest enrichment is equivalent to only one theoretical plate. Tolansky had conjectured that long-used electrolytic tin plate baths might show appreciable enrichment but calculation shows that this will not be the case.

Tolansky reports experimental data on tin isotopes which support the conclusions of Bainbridge and Wilson. Measurement on isotope ratios in commercial tin, and in tin from long used electrolytic baths show no significant differences. S.Tolansky

539.18 : 539.19

9074. ISOTOPIC MASS RATIOS, MAGNETIC MOMENTS AND THE SIGN OF THE ELECTRIC DIPOLE MOMENT IN CARBON MONOXIDE. B.Rosenblum, A.H.Nethercot, Jr and C.H.Townes.
Phys. Rev., Vol. 109, No. 2, 400-12 (Jan. 15, 1958).

Precision measurements of the J = 1 ← 0 rotational frequencies and the molecular magnetic moments for various isotopic species of carbon monoxide were made in order to determine isotopic mass ratios. A correction amounting to several hundred micromass units and evaluated from the magnetic moment has been applied for the

fact that the electrons are not spherically distributed about their respective nuclei. It is also shown that the rapidly precessing electronic angular momentum causes a "wobbling" motion of the nuclei which in turn produces a stretching of the molecule ("wobble stretching") inversely proportional to the reduced mass of the molecule, but independent of J. This stretching cannot be accurately evaluated from theory and therefore appears to be the ultimate limitation on microwave determinations of mass ratios. This correction amounts to about 20 micromass units and is evaluated by the use of the nuclear reaction value for the C^{14}—C^{12} mass ratio. The final mass ratios agree very closely with the nuclear reaction values. The sign of the electric dipole moment was determined from the relative magnetic moments of the several isotopic species and corresponds to the charge distribution, C^-O^+. This appears to be the first measurement of the sign of the electric dipole moment in any molecule.

A.

539.18 : 539.14

ISOTOPE SHIFT STUDIES OF NUCLEI. See Abstr. 9016

539.18 : 539.163

TABLE OF ISOTOPES. See Abstr. 9027

539.18

9075. DEPOSITION OF ATOMIC BEAMS. S.Wexler.
Rev. mod. Phys., Vol. 30, No. 2(I), 402-9 (April, 1958).

The author reviews the work which has been published since the early Stern—Gerlach experiment on the detection, and measurement of intensity, of molecular beams by means of condensation targets with a view to establish some criteria for selection of a surface material with high efficiency of deposition from beams of atoms. Where no information on condensation coefficient (the proportion of the atoms striking a surface which remain fixed on it) is available, the binding energy by which a condensed atom is held to a surface is a useful guide. R.Schnurmann

539.18 : 537.564

IONIZATION PRODUCED BY ATOMIC COLLISIONS. See Abstr. 8846

539.18 : 539.12

9076. SPIN RESONANCE OF FREE ELECTRONS POLARIZED BY EXCHANGE COLLISIONS. H.G.Dehmelt.
Phys. Rev., Vol. 109, No. 2, 381-5 (Jan. 15, 1958).

An experiment is described in which thermal electrons, $t_e \cong 400^\circ$ K, become polarized in detectable numbers by undergoing exchange collisions with oriented sodium atoms during which the atom orientation is transferred to the electrons. The collisions establish interrelated equilibrium values for the atom and electron polarizations which depend upon the balance between the polarizing agency acting upon the atoms (optical pumping) and the disorienting relaxation effects acting both on atoms and electrons. When now the electrons are furthermore artificially disoriented by gyromagnetic spin resonance, an additional reduction of the atom polarization ensues which is detected by an optical monitoring technique, thereby allowing a determination of the free-electron spin g-factor, g_S. Since it was experimentally convenient, at this stage only the ratio $g_J(Na)/g_S = 1.000026 \pm 0.00003$ was determined, showing no significant difference between g_S and $g_J(Na)$, the g-factor of the $^2S_{\frac{1}{2}}$ sodium ground state. From the experimental strength and width of the electron disorientation signal a lower limit was obtained for the sodium exchange cross-section with thermal electrons: $Q > 2.3 \times 10^{-14}$ cm^2. This may be compared with a theoretical exchange cross-section, $Q = 2.3 \times 10^{-14}$ cm^2, which is derived under the assumption that the $3s^2$ S_0 state of the Na^- ion has essentially zero binding energy, thereby causing strong singlet scattering while the triplet scattering is negligible in comparison. Spin—orbit coupling during collisions of the electrons with the atoms of the inert argon buffer employed to slow down wall diffusion is discussed as the chief cause for the shortness of the observed free-electron spin relaxation time, $T_e \cong 6 \times 10^{-5}$ sec. A.

539.18

9077. POLARISATION OF FREE POTASSIUM ATOMS BY EXCHANGE COLLISIONS WITH SODIUM ATOMS AND FREE ELECTRONS. P.Franken, R.Sands and J.Hobart.
Phys. Rev. Letters, Vol. 1, No. 2, 52-4 (July 15); reprinted in No. 3, 118-19 (Aug. 1, 1958).

Circularly polarized Na resonance radiation is passed through a mixture of Na and K vapour. The polarized Na atoms produced by "optical pumping" are found to transfer their polarization to K atoms by collision, the cross-section for the collision being about 5×10^{-14} cm^2, compared with a calculated value of about 7×10^{-14} cm^2. In presence of electrons produced by a discharge, the polarization is transferred to the electrons and thence to K atoms. The arrangement is similar to that of Dehmelt (see preceding abstract). G.F.Lothian

539.18

9078. ORIENTATION OF RUBIDIUM ATOMS BY SPIN EXCHANGE WITH OPTICALLY PUMPED SODIUM ATOMS.
R.Novick and H.E.Peters.
Phys. Rev. Letters, Vol. 1, No. 2, 54-5 (July 15, 1958).

In an experiment similar to that of the preceding abstract it is found that the cross-section for exchange collisions is about 2×10^{-14} cm^2 (the calculated value is about 5×10^{-14} cm^2). G.F.Lothian

539.18 : 537.564

EXCITATION OF HELIUM BY PROTONS. See Abstr. 8843

539.18

9079. ATOMIC ORIENTATION BY OPTICAL PUMPING.
W.Franzen and A.G.Emslie.
Phys. Rev., Vol. 108, No. 6, 1453-8 (Dec. 15, 1957).

A variation of the usual method of atomic orientation of alkali metal vapours by optical pumping is proposed. This variation consists of employing a single circularly polarized D_1 line as pumping radiation, instead of a mixture of the two D lines. Under these conditions, one magnetic substate of the ground state is transparent to the pumping radiation. It is shown that for a sufficiently intense light source and relatively weak relaxation, the entire population of the vapour will tend to be pumped into this single state, resulting in nearly one-hundred percent atomic orientation. The pumping process is analysed in detail for sodium vapour illuminated with $3P_{\frac{1}{2}}$—$3S_{\frac{1}{2}}$ radiation, and the time dependence of the populations of the eight magnetic sublevels of the ground state is computed. It is shown that in the steady state, the light absorption by the vapour is linear rather than exponential with distance. A simple method of measuring relaxation times based on this observation is suggested. The conditions under which the imprisonment of resonance radiation limits the size of the oriented sample are discussed, and it is suggested that the proposed technique will allow the alignment of larger samples than is possible by the usual method of optical pumping. A.

MOLECULES

539.19 : 530.145

CHARACTERISTIC EXPONENT FOR THE RADIAL WAVE EQUATION WITH A MAXWELLIAN POTENTIAL. See Abstr. 8595

539.19

9080. HIGHER IONIZATION POTENTIALS OF LINEAR TRIATOMIC MOLECULES CO_2, CS_2, COS, N_2O.
Y.Tanaka, A.S.Jursa and F.J.LeBlanc.
J. chem. Phys., Vol. 28, No. 2, 350-1 (Feb., 1958)

The ionization potentials were measured by observing the Rydberg series of these molecules using a 2-metre vacuum spectrograph. Results are tabulated and the agreement with previously recorded data discussed. G.I.W.Llewelyn

539.19 : 535.343

9081. VIBRATIONAL SPECTRUM AND STRUCTURE OF METAL-CYANIDE COMPLEXES IN THE SOLID STATE. IV. $K_3Cu(CN)_4$.
L.H.Jones.
J. chem. Phys., Vol. 29, No. 3, 463-6 (Sept., 1958).

For Pt III, see Abstr. 9082 (1957). The polarized infrared spectrum of single crystals of $K_3Cu(CN)_4$ was observed. The fundamental frequencies of $Cu(CN)_4^{-3}$ under point group T_d are assigned as 2094, 288, 324, 63, 2079, 364, 306, 74 and 250 cm^{-1}. From these frequencies, valence force symmetry force constants are calculated. Both the CN and CuC stretching force constants are found to be quite low (16.2 and 1.3 md/A, respectively). The CuC force constant, along with Badger's rule, gives a CuC distance of 2.05 A, somewhat shorter than the single bond distance of 2.12 A, predicted from the tetrahedral radii. A.

539.19

9082. VIBRATIONAL INTENSITIES. IX. C_2F_6: EXTENSION AND REVISION.
I.M.Mills, W.B.Person, J.R.Scherer and B.Crawford, Jr.
J. chem. Phys., Vol. 28, No. 5, 851-3 (May, 1958).

For previous work, see Abstr. 2940-1 (1955). The intensity of the low fundamental of C_2F_6 at 219 cm^{-1} was measured using a CsI prism. This completed earlier studies on the other fundamentals,

and permits extension and revision of the interpretation. Effective bond moments are compared with those of other fluorocarbons. A.

539.19

9083. ANHARMONIC CONSTANT x_{22} OF $N^{14}O_2$.
J.W.Keller and A.H.Nielsen.
J. chem. Phys., Vol. 29, No. 1, 252-3 (July, 1958).

This was found to be $-0.6\ cm^{-1}$, in conflict with earlier determinations. J.Hawgood

539.19

9084. ABSOLUTE INFRARED INTENSITIES OF THE FUNDAMENTAL VIBRATIONS OF NF_3. P.N.Schatz and I.W.Levin.
J. chem. Phys., Vol. 29, No. 3, 475-80 (Sept., 1958).

The absolute intensities were measured and the results are interpreted in terms of the N—F bond moment (μ), its derivative ($\partial\mu/\partial r$), and the unshared pair moment on the N atom ($\mu_{u.p.}$). The bond moment obtained from the A_1 bending mode is found to be in the vicinity of 1D. $\mu_{u.p.}$ is in the vicinity of either 1.2D or 1.7D depending upon the sign assumed for the molecular dipole moment. The bond moment calculated from the E mode is quite sensitive to the potential function. Since this function is not known with high accuracy, one is not able to determine whether the bond moments from the two different symmetry species are in agreement. There is a striking difference in the values of $\partial\mu/\partial r$ from the two symmetry species with $\partial\mu/\partial r(A_1)$ in the range 1.5 to 2D/A and $\partial\mu/\partial r(E)$ in the vicinity of 4.5 D/A. A qualitative explanation for this difference is offered. A.

539.19

9085. POTENTIAL FUNCTION OF NF_3. P.N.Schatz.
J. chem. Phys., Vol. 29, No. 3, 481-3 (Sept., 1958).

An approximate potential function is determined for NF_3 by using the four fundamental frequencies, the experimentally determined rotational distortion constant D_J, and physical arguments based on the absolute intensity results (preceding abstract). Use is also made of an argument proposed by Polo and Wilson based on a comparison of NF_3 with the isoelectronic molecule CF_3H. The rotational distortion constants are calculated as a function of the force field using the method of Kivelson and Wilson. Explicit formulae are given for the change in moment of inertia with symmetry coordinate for an $XY_3(C_{3r})$ type molecule. Using the approximate potential function, values of the valence type force constants and the rotational distortion constant D_K are calculated. A.

539.19

9086. MEAN AMPLITUDES OF VIBRATION IN ALLENE AND ALLENE-d_4 MOLECULES. I. S.J.Cyvin.
J. chem. Phys., Vol. 29, No. 3, 583-90 (Sept., 1958).

Observed fundamentals for allene and allene-d_4 are used for performing a normal coordinate analysis. Eight alternative sets of 13 force constants from the harmonic potential energy function are evaluated numerically. The normal coordinates for allene and allene-d_4 are determined. Analytical expressions for all the seven types of interatomic distance displacements are given. For each of these types, both in allene and allene-d_4, the standard deviations (here called mean amplitudes of vibration) are calculated. The obtained values at four temperatures, T = 0, 273, 298, and 323°K, are reported. A.

539.19

9087. NORMAL VIBRATIONS OF N-METHYLACETAMIDE.
T.Miyazawa, T.Shimanouchi and S.Mizushima.
J. chem. Phys., Vol. 29, No. 3, 611-16 (Sept., 1958).

The in-plane normal vibrations of n-methylacetamide and its deuterated compound were calculated as a six-body problem. The force constants were transferred from diformylhydrazine and other molecules with similar structures. The normal modes as well as the distributions of the potential energy among symmetry coordinates were also calculated. The result of these calculations allows quantitative discussions concerning the nature of the amide I, II, II', III, III', and IV vibrations and other normal vibrations of n-methylacetamide. A.

539.19

9088. HIGHER ORDER ROTATION—VIBRATION ENERGIES OF POLYATOMIC MOLECULES. IV. G.Amat and H.H.Nielsen.
J. chem. Phys., Vol. 29, No. 3, 665-72 (Sept., 1958).

For Pt III, see Abstr. 370 (1958). The contact transformations, carried out previously through the third order of approximation, are now extended through the fourth order of approximation. A.

539.19

9089. APPLICATION OF THE MASS SPECTROMETER TO THE STUDY OF THE UPPER ENERGY STATES OF MOLECULES.
J.D.Morrison.
J. appl. Phys., Vol. 28, No. 12, 1409-13 (Dec., 1957).

It is claimed that the poor agreement often found between the energy quantities measured by mass spectrometry, and those obtained by other methods, is due in large part to the interpretation of the experimental data. The conditions necessary for accurate measurement are summarized. It is shown that by making certain assumptions about the probability of ionization for different processes, ionization efficiency curves can be interpreted to give the probabilities for electronic transitions from the ground state to the various ionic states of molecules. From these electronic transition probabilities, information can be deduced about the potential energy functions for these upper states. To exploit the method fully, beams of ionizing particles with low spreads in energy are necessary. Electron and photon impact are compared, and it is shown that the latter possesses many advantages. A.

539.19

9090. SPECTROSCOPIC COMPARISON OF $\pi-\sigma$ TO $\pi-\pi$ ELECTRON FORCES BETWEEN BENZENE AND VARIOUS DILUENT MOLECULES.
W.W.Robertson, J.M.Robinson and S.E.Babb, Jr.
J. chem. Phys., Vol. 29, No. 1, 243-4 (July, 1958).

Calculated and experimental results on the wavelength shift of the benzene absorption spectrum in ethylene, ethane, and n-pentane are correlated. G.I.W.Llewelyn

539.19

9091. FINE STRUCTURE IN THE ELECTRON SPIN RESONANCE SPECTRA OF NO_2 SOLUTIONS.
G.R.Bird, J.C.Baird and R.B.Williams.
J. chem. Phys., Vol. 28, No. 4, 738-9 (April, 1958).

The N^{14} hyperfine structure in the paramagnetic resonance spectra of solutions of NO_2 in CCl_4 and CS_2 was observed at low dilution (~ 0.01%). The separation of the hyperfine structure components, 107 ± 3 gauss, indicates that the unpaired electron has 18% 2s character at the nitrogen nucleus. This is larger than has been thought to be the case, and indicates that this hyperfine coupling is an important term in the NO_2 Hamiltonian. J.M.Baker

539.19

9092. PURE QUADRUPOLE RESONANCE DETERMINATIONS OF MOLECULAR CHARGE DISTRIBUTIONS. I. SUBSTITUTED QUINONES, QUINOLINES, PYRIDINES, PYRIMIDINES, AND TRIAZINES.
P.J.Bray, S.Moskowitz, H.O.Hooper, R.G.Barnes and S.L.Segel.
J. chem. Phys., Vol. 28, No. 1, 99-102 (Jan., 1958).

The charge distributions in quinone and several heterocyclics containing nitrogen in the ring were determined from the pure quadrupole resonance frequencies of attached halogens. Agreement with values from molecular orbital calculations is good in quinone and pyridine but poor in quinoline. Quantitative measurements are presented for the effect of ring nitrogens on the double bond character of carbon—halogen bonds. A.

539.19

9093. PROTON MAGNETIC RESONANCE STUDIES OF THE ACETIC ACID, PHENOL, AND WATER IN MIXTURES WITH PYRIDINE. K.Toyoda, T.Ikenoue and T.Isobe.
J. chem. Phys., Vol. 28, No. 2, 356-7 (Feb., 1958).

In all cases the chemical shift of the hydroxyl proton passes through an extreme value at 50 mole % pyridine, and the difference between the shifts of the ortho- and para- protons of pyridine increases with pyridine concentration. From a comparison with the properties of other mixtures the existence of hydrogen bonding in these mixtures is inferred. E.F.W.Seymour

539.19

9094. NUCLEAR RESONANCE SPECTRUM AND STRUCTURE OF SF_4. F.A.Cotton, J.W.George and J.S.Waugh.
J. chem. Phys., Vol. 28, No. 5, 994-5 (May, 1958).

The nuclear magnetic resonance spectrum of the SF_4 molecule indicates that the symmetry is C_{2v}, probably the nonplanar C_{2v}. This is in agreement with deductions from the vibrational spectrum. The effects on the resonance signal of impurities in the sample are discussed. J.M.Baker

539.19

9095. APPLICATION OF THE PARISER AND PARR METHOD TO DYE IONS WITH AMIDINIUM RESONANCE.

S.P.McGlynn and W.T.Simpson.
J. chem. Phys., Vol. 28, No. 2, 297-300 (Feb., 1958).

The transition energies and transition probabilities for the family of dye ions

$$Me_2N - (CH = CH)_{n-1} - CH = \overset{+}{N}Me_2$$

are calculated using the method of Pariser and Parr. The nitrogens are taken into account by a perturbation method. Configuration interaction considering single excitations from the ground configuration is employed, though in the comparison with experiment it is judged better to use the diagonal matrix elements for the transition energies. A.

539.19

9096. THEORY OF SEPARATED ELECTRON PAIRS.
J.M.Parks and R.G.Parr.
J. chem. Phys., Vol. 28, No. 2, 335-45 (Feb., 1958).

Electron pairs in a molecule are said to be separated if (i) the molecular electronic wave-function is accurately expressible as an antisymmetrized product of individual pair wave-functions, and (ii) the individual pair functions are mutually exclusive in the sense that if all pair functions are linearly expressed in terms of Slater determinants built from some orthogonal one-electron spin orbitals, no spin orbital enters the description of more than one pair function. It is shown that the electronic energy of a system of separated electron pairs may be written in a particularly simple form, and the problem of determining the best separated electron-pair description of a particular molecule is discussed. The best orbital description of an electron-pair bond is defined to be the best wave-function for the pair that can be built from two atomic orbitals, one on each of two atoms. Systematic adjustment of individual pair descriptions one at a time is shown to provide a rigorous yet practicable procedure for obtaining best orbital descriptions for several separated electron-pair bonds in a molecule. The equations obtained are shown to simplify considerably when Mulliken approximations are introduced for certain electronic repulsion integrals. Under these approximations a single property of each bond is shown to dominate its effect on other bonds, the net charge transferred from one atom to the other in the bond. This charge is called the bond polarity parameter. The equations are rewritten in terms of polarity parameters, and a scheme is thereby obtained which is convenient for discussion of intrabond charge transfer effects in a molecule. Formulas are given for the terms to be added to the absolute electronegativity of an atom in a bond to correct for charge transfers in other bonds. It is shown that the total molecular energy of a system of separated electron-pair bonds can be expressed quite rigorously as a sum of bond energies, and the approximate invariance of bond energy to molecular environment is verified. Limitations of the assumption of separability and methods for transcending it are discussed. A.

539.19

9097. MOLECULAR ORBITAL STUDY OF Be_4.
R.D.Cloney and J.S.Dooling.
J. chem. Phys., Vol. 29, No. 2, 425-31 (Aug., 1958).

An LCAO MO SCF study is made of the square, planar Be_4 complex. A complete SCF calculation is performed at four different internuclear distances. In this series of calculations all one- and two-centre integrals are evaluated exactly and the value of each three- and four-centre integral estimated by a method considered most suitable for it. The results show the complex unstable. The energy values when extrapolated to infinite internuclear distance are in good agreement with experiment. A second series of calculations is made to determine the effect of three- and four-centre integral approximations on the energies. Here all the multicentre integrals are evaluated by one type of approximation. This introduced a relatively small change in the integral values, but large changes in the energies. The study emphasizes the need for exact values of three- and four-centre integrals before exact calculations can be undertaken. A.

539.19

9098. MORSE POTENTIALS FOR EXCITED STATES OF DIATOMIC MOLECULES. R.W.Keyes.
J. chem. Phys., Vol. 29, No. 3, 523-30 (Sept., 1958).

A model is presented, according to which the nuclear potential functions of the various electronic states of a diatomic molecule form a one-parameter family of Morse functions. The variable parameter represents the fraction of the valence electrons which are in antibonding orbitals. By using the properties of the ground state to determine the Morse constants, a relation between ω_e and r_e of the various electronic states is obtained. This relation reproduces the observed data rather than accurately. Somewhat cruder predictions of vibrational anharmonicity, $\omega_e x_e$, and of dissociation energies are also obtained. Properties of molecular ions and of bonds in polyatomic molecules are also obtained from the model. The measure of bond strength obtained from the model is similar to that deduced from electron configurations in the usual way. A.

539.19 : 537.226.6

ANALYSIS OF DIELECTRIC LOSS IN TWO UREA ADDITION COMPOUNDS: THE HINDERED SINGLE AXIS POLAR ROTATOR. See Abstr. 8745

539.19 : 539.18

MAGNETIC MOMENTS AND THE SIGN OF THE ELECTRIC DIPOLE MOMENT IN CARBON MONOXIDE. See Abstr. 9074

539.19

9099. ON A MODEL OF THE HELIX-COIL TRANSITION IN MACROMOLECULES. II. S.A.Rice and A.Wada.
J. chem. Phys., Vol. 29, No. 1, 233-4 (July, 1958).

A simple statistical model to describe the transition is noted briefly, together with a statement of the results of calculations which may be obtained from it. This model is not suitable for the discussion of helix-coil transitions in double (multiple) stranded molecules such as desoxyribose nucleic acid (DNA), and another is constructed by representing the molecule as a ladder twisted about an axis through the rungs (hydrogen bonds). The partition function for such a molecule characterized by a distribution of sequences of successive broken structural elements is stated, and the equilibrium distribution deduced. It is concluded from the results of calculations on the two models that an unzipping mechanism for the helix-coil transition is unlikely. Specific proposals on the mechanism of the thermal denaturation of DNA are given. B.J.Wilson

539.19 : 532.77

ONE-DIMENSIONAL PHASE TRANSITION IN POLYPEPTIDE CHAINS. See Abstr. 8618-19

539.19 : 538.561

9100. ANALYSIS OF A MULTIPOLE STATE SEPARATOR AND FOCUSER FOR POLARIZABLE MOLECULES. F.O.Vonbun.
J. appl. Phys., Vol. 29, No. 4, 632-6 (April, 1958).

The electrostatic field of a multipole focuser, consisting of parallel rods arranged in a circle, is treated. The field equation is derived from the known field of a two-wire line, and results are given in the form of equations that express the field in terms of practical parameters. The field and the radial gradient of a (p + q)-pole focuser is compared to that of a p-pole focuser in order to indicate the value of increasing the number of poles. Both a complete and a simplified set of differential equations (in cylindrical coordinates) of the path of polarizable molecules in this inhomogeneous field are also given. Based on the simplified differential equations, the path of a NH_3 molecule in the $J = K = 3$ ($M_J = 3$) inversion state is graphically presented. A.

539.19

9101. STUDIES OF MOLECULAR SCATTERING AT THE SOLID SURFACE. F.C.Hurlbut.
J. appl. Phys., Vol. 28, No. 8, 844-50 (Aug., 1957).

Experimental studies of molecular scattering at the gas–surface interface are described in which molecular beams of N_2 were scattered at surfaces of steel, aluminium, and glass. Polar surveys of the issuing molecule flux indicate the scattering to be well represented by a cosine distribution in most cases. A moderate deviation from such a distribution was observed in the case of the glass–N_2 interaction. It is shown how measurements of scattering at the surface may be used to derive values of the momentum transfer coefficient f(s) in a rarefied gas flow, where s is the ratio of the mass speed of the flow to the most probable thermal speed of the molecules. In order to complete the calculation where scattering information alone is available from experiment, assumptions must be made relating to the energy exchange at the surface. In the present calculation, where a surface interaction model was formed in part from the glass–N_2 scattering data, two extremal assumptions relating to the energy exchange lead to values of f(s) of approximately 0.97 at $s = 0.1$. A.

539.19

9102. VIBRATIONAL ENERGY EXCHANGE BETWEEN DIATOMIC MOLECULES AND A SURFACE. R.Herman and R.J.Rubin.
J. chem. Phys., Vol. 29, No. 3, 591-9 (Sept., 1958).

The problem of the steady-state vibrational energy distribution

of diatomic molecules that temporarily reside on a surface during exposure to a molecular beam is examined according to the rate equations proposed by Klemperer and Herschbach. It is shown that it is possible to obtain explicitly the steady-state vibrational energy distribution for different vibrational energy distributions in the incident beam and that the vibrational energy accomodation coefficient suitably defined is of a very simple form. A.

539.19 : 532.77

9103. EFFECTIVE SYMMETRIES OF ELECTRICAL FIELDS ABOUT IONS IN SOLUTION. D.G.Miller, E.V.Sayre and S.Freed.
J. chem. Phys., Vol. 29, No. 2, 454-5 (Aug., 1958).

Intensity changes in the spectra of alcoholic solutions of europium, gadolinium, and praseodymium trichlorides, brought about by gradual replacement of alcohol by water, are interpreted. The apparent changes in symmetry are thought to be caused by intramolecular oscillations. G.I.W.Llewelyn

539.19 : 536.7

9104. ADDITIVITY RULES FOR THE ESTIMATION OF MOLECULAR PROPERTIES. THERMODYNAMIC PROPERTIES. S.W.Benson and J.H.Buss.
J. chem. Phys., Vol. 29, No. 2, 546-72 (Sept., 1958).

A general limiting law is proposed which can be used to systematize the various laws of additivity of molecular properties. This can be stated as follows: If Φ is a molecular property, then for the disproportionation reaction: $RNR + SNS \rightleftharpoons 2RNS$, $\Delta\Phi \rightarrow 0$ as the separation between R and S becomes large compared to their dimensions. It is shown that the zero-order approximation is equivalent to the law of additivity of atomic properties, the first-order approximation to the law of additivity of bond properties, the second-order approximation to the law of additivity of group properties, and so forth. It is shown that for C_p and S° (ideal gases), the additivity of atomic properties works to about ±2 cal/mole deg K, while the additivity of bond properties is usually good to about ±1 cal/mole deg K. The latter also estimates ΔH_f° to about ±3 kcal/mole. The group additivity relation is generally obeyed to within ±0.5 cal/mole deg K for C_p and S° and about ±0.6 kcal/mole for ΔH_f°. Tables are presented for each of the partial properties at 25° C. The agreements found for the various additivity rules is examined from a molecular point of view and certain extensions and limitations indicated. The application and utility of the rules in estimation of thermodynamic properties is discussed. The estimation of bond dissociation energies is possible with the additivity rules as are the thermodynamic properties of free radicals. An application of the rules to species NR_3 and NS_4' show that R and S may be ordered according to their general bond-weakening or bond-strengthening properties. For systems where N is C_2H_4 it is shown that the first and second bond dissociation energies for RC_2H_4R is very likely a constant = 59.5 kcal, the excitation energy of C_2H_4. A.

SOLID-STATE PHYSICS

539.2

9105. SOLID HELIUM. N.Barth.
Naturwissenschaften, Vol. 44, No. 24, 627-9 (1957). In German.

A short review article. Because of its low critical pressure and high compressibility helium is the ideal model substance for the study of the solid state and the melting process. The melting pressure has been measured up to 55° K and the entropy of melting up to 26° K where it is still increasing, thus there is no indication of a critical point in the melting curve. Below the λ-point of the liquid the internal energy of melting changes sign owing to the predominant influence of the zero-point energy. The latter and the related Debye temperature increase strongly with decreasing molar volume. Measurements of the thermal conductivity k as function of temperature show for decreasing molar volume an increase in height and shift towards higher temperature of the maximum of the k–T curve, giving evidence of Peierls' theory of the "Umklapp" processes. H.London

539.2

9106. ON THE VIBRATIONS OF A GENERALIZED DIATOMIC LATTICE. A.Maradudin and G.H.Weiss.
J. chem. Phys., Vol. 29, No. 3, 631-4 (Sept., 1958).

Some results are given for regular diatomic chains whose unit cells contain more than two atoms. Using the transfer matrix method and certain theorems due to Hoffman and Mazur, the band structure of the frequency spectra is obtained for chains whose unit cells contain three and four atoms. Finally the constant term in the frequency spectrum of a disordered diatomic lattice is derived. A.

539.2

9107. QUADRUPOLE INTERACTIONS AND THE VIBRATION SPECTRA OF DIAMOND TYPE CRYSTALS. M.Lax.
Phys. Rev. Letters, Vol. 1, No. 4, 133-4 (Aug. 15, 1958).

It is suggested that the unusual character of the vibration spectra of germanium and silicon may be explained by allowing quadrupole–quadrupole interactions. Calculations of the effect of these interactions are in progress. B.T.M.Willis

539.2

9108. THERMAL VIBRATIONS OF ATOMS AND MOLECULES IN CRYSTALS. K.Lonsdale.
Rev. mod. Phys., Vol. 30, No. 1, 168-70 (Jan., 1958).

The problems involved in an accurate crystal structure determination are described with particular reference to small organic molecules. The author considers that with the advent of high-speed computing facilities, the essential requirement is for reliable and precise experimental data on which to work. The experimental difficulties in the study of the thermal vibrations of such substances as hexamethylene tetramine (cubic), urea, pentaerythrital, di-para-xylylene etc. are emphasized. Considerable experience is required to make accurate measurements of diffraction geometry and intensity; it is considered essential to use more than one diffraction technique and to regard as provisional any results that have not been confirmed by at least one other diffraction technique. An account of the methods being used in the author's laboratory is given. (1) X-ray diffraction methods at low and room temperatures are used for the direct determination of the coordinates of all atoms and their vibration amplitudes. It is shown how proper allowance for such effects as extinction, dispersion and absorption can be made. (2) An independent estimate of the temperature factors is obtained by measuring the variation of the diffraction intensities from a number of planes, at several temperatures. It is important to make correct allowance for the effect of change of structure on the Bragg angle. (3) The variation with temperature and direction, of the thermal expansion can be used as an auxiliary method of distinguishing vibrations which vary with temperature from those that do not and can also be used to test the accuracy of measurement of crystal geometry at different temperatures. (4) The distribution of vibrations among different frequencies can be examined by taking a series of well-exposed cylindrical Laue photographs, while X-ray photographs are being taken. (5) Controlled isotope substitution is suggested as perhaps a fruitful method. (6) Measurements of the diamagnetic susceptibilities along the principal magnetic directions, and its variation with temperature (if perceptible) can be interpreted in terms of molecular vibrations. R.Bullough

539.2

9109. INFLUENCE OF THE CRYSTAL-FIELD POTENTIAL ON INTERIONIC SEPARATION IN SALTS OF DIVALENT IRON-GROUP IONS. N.S.Hush and M.H.L.Pryce.
J. chem. Phys., Vol. 28, No. 2, 244-9 (Feb., 1958).

The crystal energies of ionic lattices containing iron group ions with nonspherically symmetric electronic ground states are appreciably lowered as a result of crystal field splitting of the lowest energy levels. This gives rise to a characteristic periodic variation of the equilibrium cation–anion separation as the 3d shell is progressively filled. It is possible to estimate the contractions of interionic separation resulting from the crystal field effect by comparison with the distances in lattices containing only ions with S ground states. In the divalent oxides and halides, these contractions are of the order of 0.04 – 0.22 A. By treating the crystal-field stabilization as a small perturbation, the contractions can be calculated for simple lattice structures. Good agreement between theory and experiment is found for oxides crystallizing in the sodium chloride lattice, with the exception of VO. The lattice contractions of D_{3d}^3 iodides and D_{4h}^{14} fluorides can also be consistently correlated with stabilization energy in these salts. A.

539.2

9110. NUMBER OF SINGLE, DOUBLE, AND TRIPLE CLUSTERS IN A SYSTEM CONTAINING TWO TYPES OF ATOMS. R.E.Behringer.
J. chem. Phys., Vol. 29, No. 3, 537-9 (Sept., 1958).

A set of graphs is presented from which one can read directly the probability that, in a lattice containing two types of atoms A and B randomly distributed over the lattice sites, a type A atom will be in a cluster of one, two, or three A atoms. Results are presented as a function of concentration for simple cubic, body-centred cubic, face-centred cubic, and hexagonal close-packed lattices. A.

539.2

9111. ABSENCE OF DIFFUSION IN CERTAIN RANDOM LATTICES. P.W.Anderson.
Phys. Rev., Vol. 109, No. 5, 1492-505 (March 1, 1958).

This paper presents a simple model for such processes as spin diffusion or conduction in the "impurity band". These processes involve transport in a lattice which is in some sense random, and in them diffusion is expected to take place via quantum jumps between localized sites. In this simple model the essential randomness is introduced by requiring the energy to vary randomly from site to site. It is shown that at low enough densities no diffusion at all can take place, and the criteria for transport to occur are given. A.

539.2

9112. THE EXCITED STATES OF A LOCAL ELECTRON CENTRE INTERACTING WITH A QUANTUM FIELD AT ARBITRARY VALUES OF THE COUPLING CONSTANT. I. APPLICATION TO THE THEORY OF F AND F' CENTRES. V.M.Buimistrov.
Ukrayin. fiz. Zh. Dodatok, Vol. 2, No. 2, 12-23 (1957). In Ukrainian, with summaries (1¾ pp.) in English and (2½ pp.) in Russian.

A variational method put forward by the author and Pekar in Abstr. 5656 (1958), is generalized to include the case of excited states. A unified analytical expression is obtained for the stationary state energy of a system of several particles interacting with a quantized field. The ground state energy of the system for weak coupling transforms into the result of the second approximation of perturbation theory, whilst for strong coupling it transforms into the result of the adiabatic approximation. By way of application the author considers the fundamental and vibration-excited states of the F and F' centres as well as the electron-excited state of the F centre. C.R.S.Manders

539.2

9113. SOLUTION OF THE BLOCH INTEGRAL EQUATION FOR ELECTRONS IN METALS IN AN ELECTRIC FIELD OVER THE WHOLE TEMPERATURE RANGE. D.Langbein.
Z. Phys., Vol. 152, No. 1, 123-42 (1958). In German.

The Bloch integral equation is treated by expressing the distribution function in a form involving components, along three axes, of a generalized mean free path. The anisotropy of the energy surfaces in k-space is taken into account. By expanding in powers of $\tan^2(\eta/2)$, where $\eta = (E-\xi)/kT$, expressions valid for all temperatures are obtained for the mean free path components as functions of temperature, an anisotropy parameter, and the wave-vector. The electrical conductivity is calculated and the Bloch–Grüneisen interpolation formula corresponds to a particular value of the anisotropy parameter. D.M.Edwards

539.2

9114. ON THE s–d EXCHANGE MODELS OF TRANSITION METALS. A.A.Berdyshev and Yu.A.Izyumov.
Fiz. Metallov i Metallovedenie, Vol. 5, No. 3, 552-3 (1957). In Russian.

The addition of weak s–d exchange to the homopolar model of a transition metal with an arbitrary number of d-electrons per atom, leads to the appearance of terms in T (temperature), $T^{1/2}$ and $T^{-1/2}$ in the formula for spontaneous magnetization. The term in T is the largest and gives ~ 10% departure from the usual $T^{3/2}$ law. This is in better agreement with experiment. A.F.Brown

539.2 : 535.343

ELECTRON BAND STRUCTURE OF Ge-Si ALLOYS. See Abstr. 8687

539.2

9115. ANISOTROPIC EFFECTS IN OPTICAL EXCITATION OF EXCITONS IN MOLECULAR CRYSTALS. D.Fox and S.Yatsiv.
Phys. Rev., Vol. 108, No. 4, 938-45 (Nov. 15, 1957).

The expression for the energy of an exciton state contains certain dipole lattice sums. These sums are strongly dependent on the direction of the propagation vector of the exciton, even when the magnitude of this vector is very small. As a result, the energy of an optically-excited exciton may depend strongly on the direction of propagation of the absorbed radiation, if the excitation takes place coherently over a region whose linear dimensions are comparable with or much larger than a wavelength. The behaviour of the lattice sums may also introduce a dependence of the exciton polarization and of the absorption coefficient on the direction of propagation. The magnitudes of these effects were calculated for the cases of the first and second transitions of napthalene and of anthracene. Experimental observations of the extent to which these effects occur could provide information on the dimensions of the region of excitation of the exciton. A.

539.2

9116. THE OSCILLATION OF THE ABSORPTION COEFFICIENT OF A CRYSTAL IN A MAGNETIC FIELD IN THE REGION OF THE DIRECT PHOTOEFFECT. L.É.Gurevich and Z.I.Uritskiĭ.
Zh. tekh. Fiz., Vol. 28, No. 5, 932-5 (1958). In Russian.

A theory of this effect is developed using quantized states of electrons and holes in the magnetic field. S.F.Edwards

539.2 : 535.377

F AND V CENTRES THERMOLUMINESCENT RECOMBINATION. See Abstr. 8706

539.2

9117. TRANSFERENCE EXPERIMENTS ON LEAD AND THALLOUS IONS IN POTASSIUM CHLORIDE CRYSTALS.
W.J.Fredericks and A.B.Scott.
J. chem. Phys., Vol. 28, No. 2, 249-52 (Feb., 1958).

The electrolytic migration of lead and thallium in potassium chloride crystals to which small additions of lead chloride had been made was studied in a transference experiment. Lead was found to migrate toward the anode, indicating that it is bound in a negatively charged complex. Thallium did not migrate appreciably at temperatures below 600°; at higher temperatures it moved toward the cathode. Thallium clearly may exist as the simple cation at elevated temperatures; however, the results at lower temperatures do not permit a conclusion to be drawn with certainty regarding the existence of complex ions. A.

539.2

9118. EQUILIBRIUM CONCENTRATION OF VACANCY PAIRS IN IONIC CRYSTALS. O.Theimer.
Phys. Rev., Vol. 109, No. 4, 1095-7 (Feb. 15, 1958).

The thermal equilibrium concentration of associated vacancy pairs in ionic crystals is calculated, taking into account the Coulomb interaction between vacancies, the entropy difference between dissociated and associated vacancy pairs, and the temperature dependence of some thermodynamic functions. Contrary to previous theoretical estimates, a formula is obtained which is consistent with the low degree of association indicated by experiments. A.

539.2

9119. CLEAVAGE CRACKS AND DISLOCATIONS IN LiF CRYSTALS. J.J.Gilman, C.Knudsen and W.P.Walsh.
J. appl. Phys., Vol. 29, No. 4, 601-7 (April, 1958).

It is shown that dislocations are nucleated ahead of the tips of cracks that move slower than $\sim 6 \times 10^3$ cm/sec in LiF crystals. The motion of cracks that move slower than $\sim 3 \times 10^3$ cm/sec is unstable, i.e. the velocity oscillates. About 2×10^5 cm/sec is the terminal velocity for (100) cleavage cracks in LiF. For constant driving force, cracks move more slowly in crystals with high dislocation densities than in relatively perfect crystals. A.

539.2 : 548.52

9120. PRODUCTION OF DISLOCATIONS DURING GROWTH FROM THE MELT. W.A.Tiller.
J. appl. Phys., Vol. 29, No. 4, 611-18 (April, 1958).

The segregation of solute on a microscopic scale during crystal growth leads to the introduction of dislocation lines into the crystal at the bounding surfaces of the segregate. A layer type of segregate resulting from platelet growth leads to dislocation densities of 10^3–10^6 lines/cm^2. A cellular type of segregation resulting from cellular or dendritic growth leads to dislocation densities of 10^6–10^8 lines/cm^2 in the crystal. A.

539.2

9121. EVIDENCE OF DISLOCATION JOGS IN DEFORMED SILICON. W.C.Dash.
J. appl. Phys., Vol. 29, No. 4, 705-9 (April, 1958).

Trails extending from dislocations in plastically deformed silicon were observed by decoration and also by an etching technique which develops channels on a {111} plane. The trails extending from screws tend to follow parallel ⟨110⟩ directions; those from mixed edge and screw dislocations are generally not crystallographic. Cusps occur where the trails are joined to the dislocations. A type of work hardening is found wherein trails from one turn of a Frank–Read spiral obstruct the motion of subsequent turns. Trails are sometimes segmented or zig-zag and appear to be composed of small discrete sections. Reversal of the direction of motion of a dislocation when the applied stress is removed is indicated by inversion of cusps. The main features of these trails can be accounted for on the basis of non-conservative motion of jogs which inject vacancies or interstitial atoms into their paths. A.

539.2

9122. DISLOCATIONS, POINT-DEFECT CLUSTERS, AND CAVITIES IN NEUTRON IRRADIATED LiF CRYSTALS.
J.J.Gilman and W.G.Johnston.
J. appl. Phys., Vol. 29, No. 6, 877-8 (June, 1958).

Micrographic techniques were used to study dislocations, point defect clusters, and cavities in neutron-irradiated LiF crystals. No evidence of inhomogeneous damage caused by "thermal or displacement spikes" was found. However, a uniform etching effect was found for doses greater than $\sim 10^{15}$ n.v.t. The etching is believed to be caused by clusters of point defects greater than 2 A but less than 50 A in size. This agrees with previous X-ray results. The defect clusters decrease in number and increase in size with increasing annealing temperatures. At temperatures greater than $\sim 400^{\circ}$C only (100) dislocation loops remain and these disappear above $\sim 600^{\circ}$C. Electron bombardment causes a similar effect. The as-grown dislocation structure of LiF is not affected by neutron bombardment. However, it becomes increasingly difficult to move fresh dislocations in crystals given neutron doses greater than $\sim 10^{12}$ n.v.t. The hardening is independent of dislocation velocity and temperature and hence cannot be caused by Cottrell-pinning of dislocations. The colour changes that accompany hardening suggests that it is caused by defect clusters rather than single defects. At annealing temperatures above $\sim 600^{\circ}$C crystallographic cavities appear in LiF crystals. They are rectangular parallelepipeds with (100) sides. Evidence is presented to show that the cavities are not caused by fission gases but probably by loss of fluorine from the crystals. A.

539.2 : 535.554

BIREFRINGENCE CAUSED BY EDGE DISLOCATIONS IN SILICON. See Abstr. 8716

539.2 : 537.529

NUCLEATION OF DISLOCATIONS ACCOMPANYING ELECTRIC BREAKDOWN IN LiF CRYSTALS. See Abstr. 8799

539.2

9123. PARTIAL POLYGONIZATION IN IMPURE COPPER CRYSTALS. F.W.Young, Jr and N.Cabrera.
J. appl. Phys., Vol. 28, No. 7, 787-91 (July, 1957).

A method to produce etch pits in o.f.h.c. copper by electroetching is presented and used to show that "partial polygonization" occurs in o.f.h.c. copper at or above 900°C. This does not seem to occur in 99.999% copper, indicating that impurities might facilitate climbing of dislocations at high temperatures. A.

539.2

9124. POLYGONIZATION OF COPPER. F.W.Young,Jr.
J. appl. Phys., Vol. 29, No. 5, 760-4 (May, 1958).

It was demonstrated that dislocations can be revealed as etch pits in copper crystals doped with a small amount of Te. The progress of polygonization of such copper after bending was followed with etch pits and X-ray diffraction. It was found that climbing occurred at 500°C and that polygonization was complete after 2 hr at 1000°C. In similar experiments with three samples of nominally 99.999% copper, the one which was probably purest did not polygonize, while the other two did so. This indicates that if impurity is necessary for polygonization, only a very small amount is required. A.

539.2

9125. X-RAY STUDY OF POLYGONIZATION IN COPPER SINGLE CRYSTALS.
C.T.Wei, M.N.Parthasarathi and P.A.Beck.
J. appl. Phys., Vol. 28, No. 8, 874-7 (Aug., 1957).

Single crystals of electrolytic tough pitch copper and of high purity (99.999%) copper were deformed by bending. The substructure in the as-bent and annealed crystals were studied by means of sensitive X-ray techniques. It was found that regardless of purity, crystals of certain orientations in the as-bent condition do not have subboundaries detectable by the methods used. Polygonization took place only upon prolonged annealing at around 97% of the absolute melting point and, at least in one high purity crystal, not even under those conditions. The sluggishness of the polygonization in copper is experimental evidence for the low rate of climb of extended dislocations predicted by Seeger (Abstr. 5726/1055). A.

539.2

9126. NUCLEAR QUADRUPOLE RESONANCE AT LOW FREQUENCY. L.B.Robinson.
Canad. J. Phys., Vol. 35, No. 11, 1344-5 (Nov., 1957).

Resonances of Na^{23} in sodium thiosulphate and of Al^{27} in spodumene were observed in fields between 0 and 30 gauss. Values derived for the quadrupole coupling constant and the asymmetry parameter of the electric field gradient agree satisfactorily with those obtained at high magnetic fields. D.J.Oliver

539.2 : 532.7

9127. NUCLEAR MAGNETIC RESONANCE OF MOLTEN AND SOLID THALLIUM SALTS. T.J.Rowland and J.P.Bromberg.
J. chem. Phys., Vol. 29, No. 3, 626-30 (Sept., 1958).

Chemical shifts associated with the species present in some molten and solid thallium salts were investigated using nuclear magnetic resonance. Shifts between the solid and liquid resonances of three simple ionic thallium salts at their melting points were measured. A correlation with electronegativity is indicated. Resonance absorptions, which corresponded to the thallous and thallic states, were found in the molten complex salts Tl_2Cl_4 and Tl_2Br_4. The separation of these absorptions was found to be temperature dependent, and an explanation based on exchange is discussed. One can infer from this that the average lifetimes of the species are about 10^{-5} sec at 500°K. A.

539.2

9128. DETERMINATION OF SPIN–LATTICE RELAXATION TIME FROM THE SHAPE OF THE [PARAMAGNETIC] ABSORPTION CURVE IN PARALLEL FIELDS. K.P.Sitnikov.
Zh. éksper. teor. Fiz., Vol. 34, No. 5, 1090-2 (1958). In Russian.

It is shown how the spin–lattice relaxation time ρ can be determined from the shape of the paramagnetic absorption curve in parallel fields. For experimental verification of the method the normal paramagnetic substance $MnSO_4.4H_2O$ is used. Results of measurement of ρ at room temperature and at various values of the constant magnetic field are presented for the salts $CrK(SO_4)_2.12H_2O$, $FeNH_4(SO_4)_2.12H_2O$ and $CuSO_4.5H_2O$, for which the values of ρ have not been previously known. A.

539.21 : 539.311.33

POST-BOMBARDMENT CONDUCTIVITY IN MgO CRYSTALS. See Abstr. 8770.

STRUCTURE OF SOLIDS

539.213.1

9129. THE GLASSY STATE FROM AN ATOMIC AND MOLECULAR VIEW. H.Salmang.
Naturwissenschaften, Vol. 45, No. 1, 4-6 (1958). In German.

Reviews briefly the evidence of the past twenty years for atomic and molecular binding in glasses and concludes that the representation of the structure by crystals with mixed binding has not been sufficiently considered. S.Weintroub

539.215.08

9130. THERMAL PRECIPITATOR FOR CONTINUOUS AEROSOL SAMPLING. C.Orr and R.A.Martin.
Rev. sci. Instrum., Vol. 29, No. 2, 129-30 (Feb., 1958).

The instrument operates continuously by depositing particles upon a moving tape or substrate. Complete collection of particles (resolvable with an electron microscope) was attained in a 3 in. diameter precipitating zone at a flow rate of 1 litre/min. A.

539.217 : 532.63

9131. VOLUMES AND SURFACE AREAS OF PENDULAR RINGS. W.Rose.
J. appl. Phys., Vol. 29, No. 4, 687-91 (April, 1958).

A packing of spheres is taken as a suitable model of porous media. The packing may be regular and the sphere size may be uniform, but in general, both should be random. Approximations are developed to give the volumes and surface areas of pendular rings that exist at points of sphere contact. From these, the total free volume and interfacial specific surface area are derived as expressive of the textural character of the packing. It was found that the log–log plot of volumes and surface areas of pendular rings vary linearly with the angle made by the line joining the sphere centre and the line from the centre of the largest sphere to the closest edge of the pendular ring. The relationship, moreover, was found not to be very sensitive to variation in the size ratio of the spheres in contact. It also was found that the addition of pendular ring material to various sphere packings results in an unexpected decrease in the surface area of the boundaries that confine the resulting pore space. A.

539.217

9132. STRESS-ENHANCED DIFFUSION IN GLASS. I. GLASS UNDER TENSION AND COMPRESSION. K.B.McAfee,Jr.
J. chem. Phys., Vol. 28, No. 2, 218-26 (Feb., 1958).

Describes a new technique for the determination of diffusion constants of gases in gas–solid systems. The method demands a careful analysis of the transient quantity of gas flowing after the gas pressure at the boundary is discontinuously changed. The exact qua tity of gas flowing is recorded by a mass spectrometer. The method was used to study the effect of high tensile stress upon the diffusion constant of helium and other gases in glass. The diffusion constant of helium was found to be a true constant with dilation of the glass until the stress became about one-half the breaking stress of the glass. Beyond this point the diffusion constant increased, and under very high stress was a factor of ten larger than its original value. No apparent change was produced in the glass, and reduced stress gave the same diffusion constant as previously, indicating reversibility of the effect with stress. It was further determined that equal and even larger compressional stresses on the same glass specimen had little or no effect upon the diffusion constant. The effect of shear stress upon the diffusion constant is dealt with in Pt II (abstract following). The magnitude of the observed increase in diffusion constant is larger by a considerable factor than can be explained by a straightforward extension of prevalent theories of diffusion in glass. If it is assumed that the glass sample dilates on an atomic scale, i.e., each atom being isotropically displaced by the stress, then calculations show that the diffusion constant should not be strongly increased under stress. Observation of the large increase then points towards the opening of flaws or voids within the glass. Diffusion of hydrogen, heavy water, oxygen, and nitrogen is discussed and upper limits for diffusion of the latter three under high stress are set. A.

539.217

9133. STRESS-ENHANCED DIFFUSION IN GLASS. II. GLASS UNDER SHEAR. K.B.McAfee,Jr.
J. chem. Phys., Vol. 28, No. 2, 226-9 (Feb., 1958).

Glass was subjected to large shear strain to determine its effect upon the diffusion rate of gases through the solid. It was found that shear strain, γ, up to 4×10^{-3} does not alter the diffusion constant appreciably in the glass. Additional evidence is presented in support of the conclusion of the previous paper that the large increase in diffusion constant in glass results from the effect of tension. Arguments are expanded which support the interpretation that stress enhancement is caused by the reversible opening of submicroscopic fissures or channels in the random glass network. A.

539.217

9134. DIFFUSION OF COBALT AND CHROMIUM IN CHROMITE SPINEL. R.Sun.
J. chem. Phys., Vol. 28, No. 2, 290-3 (Feb., 1958).

The diffusion of cobalt and chromium in sintered samples of $CoCr_2O_4$ was measured in the temperature region 1400°C-1600°C where it is believed that bulk diffusion predominates. The diffusion can be represented as $D_{Co} = (10^{-3}) \exp(-51\,000/RT)$, $D_{Cr} = (2) \exp(-70\,000/RT)$. A.

539.217

9135. SOLUTIONS OF SULFUR IN FUSED SALTS.
J.Greenberg, B.R.Sundheim and D.M.Gruen.
J. chem. Phys., Vol. 29, No. 2, 461 (Aug., 1958),

Absorption spectra of sulphur fused in LiCl/KCl and LiBr/KBr eutectics and in KSCN, at 400°C, suggest that it appears as diatomic molecules in a triplet ground state in each case. Gouy measurements in the first case show slight paramagnetism. P.Gray

539.217

9136. VOLUMES OF ACTIVATION FOR DIFFUSION IN SOLIDS.
R.W.Keyes.
J. chem. Phys., Vol. 29, No. 3, 467-75 (Sept., 1958).

Activation volumes for the following simple models of lattice defects are calculated: (a) simple vacancy in a monatomic lattice, (b) simple vacancy with elastic theory of relaxation, (c) Schottky defect in an ionic crystal with dielectric theory of relaxation, (d) surface tension model of a vacancy in a metal, (e) elastic sphere model of an interstitial atom, and (f) strain energy theory of defect motion. The calculations are compared with experimental measurements. The comparison is satisfactory in many cases. In particular it is observed that most of the data can be represented by the equation $\Delta V = 4\beta\Delta H$ (β = compressibility, ΔH = activation energy), and that an equation of this type can be derived from several of the models. This equation can be used with a result of Lawson's to derive Zener's expression for the activation entropy of diffusion. A.

539.217

9137. SELF DIFFUSION AND IMPURITY DIFFUSION IN LEAD TELLURIDE AND SELENIDE. B.I.Boltaks and Yu.N.Mokhov.
Zh. tekh. Fiz., Vol. 28, No. 5, 1046-50 (1958). In Russian.

The cylindrical diffusion specimens (about 150 of PbTe) were cut from single crystal ingots (prepared by the Bridgman method and subjected to a prolonged homogenising anneal). A radioactive isotope of the element to be studied was evaporated on to one end, and the specimens were annealed in evacuated ampoules in pairs with the active faces pressed together. The diffusion coefficients, D, were subsequently determined by removing successive layers and radiochemically analysing them. Values of D were determined in PbTe from 500°-800°C and in PbSe from 650°-850°C. The results are tabulated and graphs show that in all cases they fitted relations of the form $D = D_0 \exp(-E/kT)$. The values of D_0 (in cm^2/sec) and E (in eV) for the elements studied in the matrix indicated are as follows

Element	Te	Sb	Sn	Se	Sb
Matrix	PbTe	PbTe	PbTe	PbSe	PbSe
D_0	2.7×10^{-6}	4.9×10^{-2}	3.1×10^{-2}	2.1×10^{-5}	0.34
E	0.75	1.54	1.56	1.2	2.0

Vacancy mechanisms of diffusion were thought probable. The low values of E for self-diffusion in PbTe are correlated with the low heat of formation of PbTe. The anomaly that E is higher for impurity than for self-diffusion is explained as due to the tendency to form stable complexes of the type Sb_2Te_3, SnTe, and Sb_2Te_3.

K.F.Hulme

539.217 : 539.17

HYDROGEN DIFFUSION IN METALS. DEUTERON BOMBARDMENT STUDY. See Abstr. 9055

539.219 : 535.345

9138. OXYGEN CONTENT OF SILICON SINGLE CRYSTALS.
W.Kaiser and P.H.Keck.
J. appl. Phys., Vol. 28, No. 8, 882-7 (Aug., 1957).

The oxygen content of pulled silicon crystals, determined by vacuum fusion gas analysis, is correlated with the infrared absorption at 9μ. In vacuum and in helium or hydrogen of 1 atm, the oxygen concentration of a liquid zone of silicon (about 20 mm^2 in cross-section) can be rapidly decreased. In an oxygen atmosphere or in contact with quartz, liquid silicon picks up oxygen quite readily. A maximum oxygen content of 2×10^{18} oxygen atoms per cm^3 was observed. Silicon single crystals pulled from a quartz crucible exhibit fluctuations in oxygen concentration both perpendicular and parallel to the pulling direction. Explanations of these effects are offered and the influence of various pulling parameters is discussed. A.

539.219 : 538.221 : 621.318.22

9139. PHASE ANALYSIS OF ALNICO V BASED ON TEMPERATURE EFFECTS. R.K.Tenzer and K.J.Kronenberg.
J. appl. Phys., Vol. 29, No. 3, 302-3 (March, 1958).

A magnetic analysis of the composition of the two Alnico V phases was attempted. Structure-independent properties, like saturation magnetization and temperature coefficient, serve to indicate the correctness of alloys supposed to represent these phases. A model of the two-phase structure of Alnico V is derived from electron micrographs. The combined saturation magnetization and the combined temperature coefficients are calculated with this model using the measured properties of the single alloys. The two alloys whose combined properties come closest to those of Alnico V consist mainly of NiAl and Fe_2Co, respectively. A.

539.219

9140. DEFENSE OF THE STRAIN-ENERGY APPROACH FOR SMALL SOLUTE ATOMS. A.S.Nowick.
J. Phys. Chem. Solids, Vol. 5, No. 1-2, 147 (1958).

It is shown that Oriani's argument (J. Phys. Chem. Solids, Vol. 2, 327, 1957) for the non-self-consistency of the strain-energy model fails through neglecting the existence of a surface-energy term. D.M.Edwards

539.219

9141. SOLID SOLUTION IN $A^{III}B^{V}$ COMPOUNDS.
J.C.Woolley and B.A.Smith.
Proc. Phys. Soc., Vol. 72, Pt 2, 214-23 (Aug., 1958).

Ranges of solid solution were investigated in systems composed of two $A^{III}B^{V}$ compounds, particularly GaSb–InSb, GaAs–InAs and

InAs—InSb. It is found that in practically all cases considered complete solid solution throughout the whole range of composition can be obtained, but that this equilibrium condition can only be reached under special conditions of temperature and time of annealing. The work includes the investigation of solidus curves and the possible presence of low temperature miscibility gaps. In all cases, it is found that if normal annealing methods are used, equilibrium can be attained with a reasonable length of time of anneal only in the case of compressed powder specimens. Consideration is given to the methods available for producing alloys in equilibrium in the solid form. A.

539.219 : 537.311.33

9142. DISTRIBUTION OF Sb IN QUENCHED Ge—Sb ALLOYS. G.Pröpstl and G.Zielasek.
Z. angew. Phys., Vol. 10, No. 5, 201-4 (May, 1958). In German.

These alloys enabled extremely small but strictly defined proportions of an impurity (e.g. Sb) to be added to the semiconductor material (e.g. Ge). It is obviously necessary to have Sb distributed uniformly throughout Ge. It was believed that this could be attained by quenching in distilled water the Ge—Sb melt contained in a cylindrical vessel (silica tube or graphite crucible). Measurements of electrical resistance conducted on cylindrical test-pieces by means of probes seemed to confirm this belief (uniform distribution of Sb across each section was postulated). The Sb accounted for in resistance measurements amounted to about 1% of the Sb used for the alloy preparation. Radiometric measurements (with Sb^{122} and Sb^{124}) showed that $> 90\%$ of Sb remained in the alloy, and only $< 10\%$ vaporized during melting. It was found that the concentration of Sb in the surface layer was very low; the next layer showed great irregularities as regards Sb content (alternating "stripes" rich and poor in Sb), whereas the core had a higher and almost uniform concentration of Sb. F.Lachman

539.219 : 548.736

SOLID SOLUTIONS OF ALUMINIUM CALCIUM FERRITES. See Abstr. 8527

539.219 : 537.311.31

SHORT-RANGE ORDER AND ELECTRICAL RESISTIVITY OF ORDERING ALLOYS. See Abstr. 8757

539.234

9143. ELECTRODES FOR THIN METAL FILMS. S.Chandra and G.D.Scott.
J. sci. Instrum., Vol. 35, No. 9, 349-50 (Sept., 1958).

The methods usually employed for providing electrodes for thin evaporated films are not entirely satisfactory. In a new method, here described, copper wires are fastened to the ends of a glass strip onto which a heavy coating of silver is then evaporated. Part of the strip is left uncoated, and on this the thin metal film is deposited so as to overlap the heavy silver coating. P.M.Davidson

539.234

9144. A NEW SIMPLE METHOD FOR THE PRODUCTION OF THIN METAL FILMS IN THE FORM OF NARROW BANDS. S.Tunakan.
Rev. Fac. Sci. Univ. Istanbul C, Vol. 22, No. 1, 54-8 (Jan., 1957). In German.

Cu, Ag, Au and Al films in the form of strips 1 mm wide and 10-12 mm long are deposited by evaporation on glass carriers covered with a layer of Formvar. When the carriers are immersed in chloroform the films float off and may then be withdrawn from the liquid. Films of thicknesses down to 0.4 μ are easily removed, but for thicknesses down to 0.1 μ special precautions must be taken. S.Weintroub

539.234 : 537.529

ELECTRIC BREAKDOWN OF CdS EVAPORATED LAYERS. See Abstr. 8800

539.26

9145. QUANTITATIVE METHOD FOR THE DETERMINATION OF FIBER TEXTURE. B.D.Cullity and A.Freda.
J. appl. Phys., Vol. 29, No. 1, 25-30 (Jan., 1958).

A semi-direct diffractometer method, requiring little or no specimen preparation, was developed for the determination of fibre texture in wire or rod. The method is applied to cold-drawn, high-purity aluminium wire, which is found to have a double fibre-texture: 80% of the specimen volume has a [111] texture and 20% a [100] texture. A.

539.264

9146. TRIDIRECTIONAL X-RAY PATTERNS OF ORIENTED FILM AT WIDE AND SMALL ANGLES. W.O.Statton and G.M.Godard.
J. appl. Phys., Vol. 28, No. 10, 1111-13 (Oct., 1957).

Drawn, oriented film of polyethylene terephthalate was studied by means of an X-ray diffraction technique in which the X-ray beam was directed in three mutually perpendicular directions: (1) through the film, (2) and (3) in the plane of the film, parallel and normal to the direction of draw. Patterns were obtained in each of these directions for the diffractions occurring at both small and large angles. This combination of patterns provides a picture of the film's polymer texture with these parameters: size, orientation, and arrangement of crystallites; extent of amorphous material; shape of microvoids. In this film the crystallites have planar orientation and are 45 A wide in the plane. A long period of 125 A exists in the direction of draw and is comprised of 75 A crystallite length and 50 A amorphous material. There is evidence that the film is composed of lamellae about 60 A thick; these lamellae are stacked in a staggered arrangement such that the crystallites in one lamella are adjacent to the amorphous regions in the lamella below. The small angle diffraction evidence cannot be reconciled with the "coiled ribbon" arrangement recently proposed in the literature to explain off-meridional diffraction spots. A.

539.27

9147. STRUCTURE OF SPHERULITES AS REVEALED BY SELECTED-AREA ELECTRON DIFFRACTION AND ELECTRON MICROSCOPY. R.G.Scott.
J. appl. Phys., Vol. 28, No. 10, 1089-90 (Oct., 1957).

Two-dimensional spherulites in thin films of 6—6 nylon were studied by selected-area electron diffraction, bright-field and dark-field electron microscopy. The electron diffraction patterns were found to be comparable to studies using limited area X-ray diffraction. In this sample they showed that the molecules were arranged in sheets with the hydrogen bonds in the plane of the film. Large field areas were used and as a result no preferred direction of orientation was seen. However, in dark-field electron microscopy, by using only those Bragg electrons scattered into limited portions of the principal rings, the radical growth and branching of discrete crystalline regions was seen. Bright field electron microscopy showed the surface morphology of these structures. A.

539.27 : 537.311.33

9148. SURFACE STUDIES ON SINGLE-CRYSTAL GERMANIUM. S.G.Ellis.
J. appl. Phys., Vol. 28, No. 11, 1262-9 (Nov., 1957).

The condition of the surface of germanium crystals was studied by chemical, electron microscope, electron diffraction, and other techniques after several of the standard etching procedures. The surface is often partially covered by particles believed to be germanium monoxide. An etch was devised which gives a controlled thickness of germanium monoxide on the crystal. Another etch minimizes the oxide formation. A simple light-scattering method for checking the surface cleanliness is described. The results of surface recombination velocity, and channel effect measurements on crystals treated by these methods are described, as is a method for obtaining low surface recombination on n-type crystals. A.

539.27 : 538.221

9149. SOME RESULTS OF AN ELECTRON MICROSCOPICAL STUDY OF THE METALLOGRAPHIC STRUCTURE OF TWO ALLOYS FOR PERMANENT MAGNETS (TICONAL G AND TICONAL X). J.J.de Jong, J.M.G.Smeets and H.B.Haanstra.
J. appl. Phys., Vol. 29, No. 3, 297-8 (March, 1958).

The microstructures of Ticonal G and Ticonal X in the condition of optimum magnetic properties are studied by the electron microscope using the direct carbon replica. It is shown that: (a) The main structural patterns for Ticonal G and X are the same; (b) the details of the structure of Ticonal G and X differ strikingly with respect to texture, width, length-to-width ratio, delineation and intergrowth; and (c) the influence of the magnetic field during cooling on the structure of Ticonal G on a plane $\|H_u$ can be shown directly. It cannot yet be decided whether the structure in the optimum condition is a true two-phase structure or a single-phase structure with periodic fluctuations in composition. It is possible that the dimensions revealed by etching do not represent those of the magnetic areas. A.

539.27 : 533.59

9150. A TABLE-TYPE, VACUUM EVAPORATION DEVICE FOR ELECTRON MICROSCOPY. K.Ulbert.
Slaboproudý Obzor, Vol. 19, No. 6, 381-4 (1958). In Czech.

The device is an accessory to a Czechoslovak table-type electron microscope. It is in the form of a box, having overall dimensions of 24.5 × 30 × 38 cm, fitted with a glass window pane.

The box is provided with two removable, vacuum-tight, double-cylindrical tubes which are inserted into the apertures in its side walls. One of the tubes contains a heating spiral and a holder for the material to be evaporated. The other tube contains a holder for the samples to be coated with the metal film. The device can be connected to the rotary pump of the microscope and it is also fitted with its own oil diffusion pump. The instrument is provided with a Penning vacuum gauge and a photoelectric cell for measuring the thickness of the deposited film. The instrument is ready for use in about 10 minutes after switching on and it is capable of coating 60 samples per hour. R.S.Sidorowicz

539.27

9151. THE ELECTROSTATIC CHARGING OF PHOTOGRAPHIC MATERIALS IN THE ELECTRON MICROSCOPE. E.Kinder.
Z. angew. Phys., Vol. 10, No. 2, 95-8 (Feb., 1958). In German.

A method is given for determining the potentials developed on photographic materials during exposure. Unless the potentials are minimized either by earthing the plate backing or by coating the backing with a thin conducting film of metal, unsharp pictures may result, especially with slow fine-grain emulsions. R.Reed

ELASTICITY. STRENGTH. RHEOLOGY

539.312

9152. MECHANICAL RESONANCE DISPERSION IN METALS AT AUDIO-FREQUENCIES. E.R.Fitzgerald.
Phys. Rev., Vol. 108, No. 3, 690-706 (Nov. 1, 1957).

Measurements of the complex shear compliance ($J^* = J' - iJ''$) of pure, polycrystalline lead, indium, and aluminium at closely spaced frequencies in the a.f. range have resulted in the discovery of multiple frequency dispersions of the resonance type. Values of the loss compliance (J'') are found to have sharply defined maxima in the range from 100 to 5000 c/s; values of the storage compliance (J') rise to a maximum and then drop to pass through a minimum as a narrow (50 to 100 c/s wide) dispersion region is traversed in the direction of increasing frequency. The shapes of the complex compliance v. frequency curves are thus similar to those found for the variation of the complex index of refraction with frequency (in absorption bands) at infrared and optical frequencies. The results indicate the presence of a dispersion mechanism different from those leading to the relaxation dispersions previously observed in connection with the mechanical properties of metals. Results on lead indicate that some of the resonances can be eliminated by high-temperature annealing of the sample material. The possibility that dislocation vibrations are responsible for the observed phenomena is considered, but no specific mechanism is found to explain the results. A number of dislocation theories are examined but these fail to predict any mechanical resonance dispersion at audio-frequencies. In addition to their theoretical implications, the results are believed to be of considerable practical importance since they indicate that certain materials when subject to mechanical vibrations of relatively low frequencies may undergo large changes in modulus at a particular frequency or frequencies. A.

539.312

9153. MECHANICAL RESONANCE DISPERSION IN CRYSTALLINE POLYMERS AT AUDIO-FREQUENCIES. E.R.Fitzgerald.
J. chem. Phys., Vol. 27, No. 5, 1180-93 (Nov., 1957).

Results similar to those of the preceding abstract are reported for crystalline polymers (polytetrafluorethylene, linear polyethylene and polyvinyl stearate). The magnitudes of the mechanical loss maxima and the frequencies at which the effect is observed depend on the static stress history and state of the sample material as well as temperature.

539.32 : 537.228.1

ELASTIC CONSTANTS OF ALPHA-QUARTZ. See Abstr. 8755

539.32 : 538.652 : 538.27

ELASTIC PROPERTIES OF FERROMAGNETIC SUBSTANCES. See Abstr. 8932

539.374 : 537.311.33

9154. ON THE MOTION OF POSITIVE HOLES IN $Li_xMn_{1-x}O$. R.C.Miller and R.R.Heikes.
J. chem. Phys., Vol. 28, No. 2, 348-9 (Feb., 1958).

Reports elastic loss measurements on these compounds with $x = 0.006$ and $x = 0.024$ at various frequencies below 1000 c/s over a temperature range from -50°C to $+150^\circ$C. The results are interpreted to support the hole mechanism of electrical conduction suggested by Heikes and Johnston (Abstr. 5333/1957). D.M.Edwards

539.379 : 538.221

EFFECT OF ELASTIC BENDING ON MAGNETIC PROPERTIES OF ORIENTED SILICON IRON. See Abstr. 8897

539.4.016 : 538.221

MAGNETIC ANISOTROPY INDUCED BY MAGNETIC ANNEALING AND BY COLD WORKING OF Ni_3Fe CRYSTAL. See Abstr. 8892

539.434

9155. SOME OBSERVATIONS ON CREEP IN ZINC SINGLE CRYSTALS. H.P.Stüwe.
J. appl. Phys., Vol. 29, No. 3, 566-9 (March, 1958).

A concentrated load, applied to the surface of a Zn single crystal, produces a hexagonal dimple if this surface is parallel to the basal plane of the crystal lattice. The rim of these dimples is formed by six sets of edge dislocations moving into the six slip directions with increasing loading time, thus causing the dimple to grow. The dimple contours can be photographed with a microfocus X-ray tube. Measurements of a large number of dimples showed: (1) for a given loading time, dimple size increases linearly with the applied load; (2) for a given load, dimple size increases with loading time until the shear stress at the dimple rim has been lowered to a value characteristic for the material used, below which creep velocity is either zero or extremely low; (3) this critical shear stress is independent of temperature; (4) it depends on the impurity concentration of the crystal in the way predicted by the model of Cottrell. A.

539.6 : 535.378

RADIATION DUE TO ADHESIVE BREAKS BETWEEN HIGH POLYMERS AND GLASS. See Abstr. 8707

539.61

9156. THEORY OF PEELING THROUGH A HOOKEAN SOLID. J.J.Bikerman.
J. appl. Phys., Vol. 28, No. 12, 1484-5 (Dec., 1957).

When the adhesive is a Hookean solid and the adhesive joint between a rigid plate and a flexible ribbon is peeled, the force required for peeling is

$$0.3799\, w\sigma(E/E_1)^{1/4}\delta^{3/4}y_0^{1/4},$$

if w denotes the width of the ribbon, σ the tensile strength of the adhesive, E and E_1 the moduli of elasticity of the ribbon and the adhesive, respectively, δ the thickness of the ribbon, and y_0 the initial thickness of the adhesive film. If $\delta = y_0$, the ratio of tensile force to stripping force needed for separation is of the order of l/y_0, l being the length of the ribbon. A.

PHYSICAL CHEMISTRY

PHASE EQUILIBRIUM. CHEMICAL REACTIONS

541.124 : 539.19

9157. STATISTICS OF POLYMER MOLECULAR SIZE DISTRIBUTION FOR AN INVARIANT NUMBER OF PROPAGATING CHAINS. L.Gold.
J. chem. Phys., Vol. 28, No. 1, 91-9 (Jan., 1958).

A detailed study of the polymer statistics for a reaction system resembling the ethylene oxide initiator case is made allowing for different rates of initiation k_i and propagation k_p. The modified Poisson distribution that results necessitates evaluation of rather complicated summations in order to characterize the number $\bar{x}_n$ and weight average $\bar{x}_w$ molecular weights. It is found that $r = k_p/k_i$ as large as 10^6 still does not shift $(\bar{x}_w/\bar{x}_n)_{max}$ beyond the range 1.3 to 1.4. But under any circumstance, depletion of monomer assures homogeneous polymers, regardless of r. A.

541.124

9158. CALCULATION OF THE ENERGY OF ACTIVATION FOR SOME SIMPLE REACTIONS. I. ORTHO–PARA HYDROGEN REACTION. E.R.Lippincott and A.Leifer.
J. chem. Phys., Vol. 28, No. 5, 769-74 (May, 1958).

A model is proposed from which energies of activation and potential energy surfaces of three atom reactions may be calculated. The method makes use of internuclear attractive and repulsive potential functions which have been derived from a quantum mechanical delta-function model. The energy of activation of the ortho–para hydrogen reaction was calculated and found to have a value of 8.5 kcal in agreement with the experimental value. The model predicts the presence of a slightly stable H_3 complex. This complex, however, is asymmetric, located at a minimum in the potential curve just before the barrier, and is stable by an energy of about 1 kcal. The method may be classified as semiempirical. However, all parameters used are obtained theoretically from the proposed model. One advantage of the method is that the main points of interest on the potential energy surface may be calculated without calculating a complete potential energy surface. A.

541.124 : 530.162

MEAN FIRST PASSAGE TIME FOR A RANDOM WALKER AND ITS APPLICATION TO CHEMICAL KINETICS. See Abstr. 8598

541.124 : 532.511

HYDRODYNAMICS OF A REACTING AND RELAXING FLUID. See Abstr. 8607

541.124 : 539.167.3

RESIDUAL CONCENTRATION OF A DAUGHTER SUBSTANCE REMOVED BY A BIMOLECULAR REACTION. See Abstr. 9044

541.126 : 535.379

9159. AIR AFTERGLOW AND KINETICS OF SOME REACTIONS OF ATOMIC OXYGEN. F.Kaufman.
J. chem. Phys., Vol. 28, No. 2, 352-3 (Feb., 1958).

The intensity of the air afterglow is found to be independent of the nature and concentration of added gases provided O is in excess and some NO_2 is present. Several rate constants for reactions involving atomic O have been determined at 23° C.

G.I.W.Llewelyn

541.126

9160. STOICHIOMETRY, SPECTRA, AND MECHANISM OF LIGHT EMISSION FOR DIBORANE–NITRIC OXIDE EXPLOSIONS. W.Roth.
J. chem. Phys., Vol. 28, No. 4, 668-70 (April, 1958).

Analysis of products, spectra, and peak light output measurements of spark ignited mixtures of B_2H_6 and NO indicate that NO probably reacts with B_2H_6 much more rapidly than with H_2 and that thermal decomposition of NO is extensive. This leads to the prediction of multiple burning zones for B_2H_6–NO flames. Emission of a continuum in the visible and ultraviolet is ascribed to formation of electronically excited NO_2 and some reactions probably involved in the mechanism are discussed. A.

541.127

9161. STATISTICAL THEORY OF CHEMICAL REACTION RATES. J.C.Keck.
J. chem. Phys., Vol. 29, No. 2, 410-15 (Aug., 1958).

A "statistical" theory of chemical reaction rates based on "scattering theory" in the strong coupling approximation is presented. The theory is developed explicitly for reactions involving the dissociation and recombination of a diatomic molecule in the presence of an atomic catalyst but is also readily applicable to other reactions. The theory formally includes Wigner's theory of three-body recombination and the classical theories of both recombination and dissociation. A limited comparison with experiment shows reasonable agreement. A.

541.127

9162. REACTION RATES AND AFFINITIES. P.Van Rysselberghe.
J. chem. Phys., Vol. 29, No. 3, 640-2 (Sept., 1958).

A new definition of elementary reactions is being based upon the Marcelin–De Donder formulation of reaction rates. Complex reactions resulting from sequences of elementary reactions are examined, under steady-state conditions, both close to, and far from equilibrium. In the former case the over-all rate is proportional to the over-all affinity, while in the latter case, when all steps are far from their equilibria, the over-all rate varies exponentially with the over-all affinity. The problem of the identification of rate-determining steps is discussed on the basis of the adopted definition of elementary reactions. Application of the treatment to the two-step sequence $A + B \rightleftharpoons C$, $C \rightarrow D + E$ leads to a close connection with the absolute rate theory. A.

541.127 : 532.77

REACTION KINETICS IN NUCLEOPHILIC SUBSTITUTION. See Abstr. 8617

ELECTROCHEMISTRY

541.135 : 532.77

SCREENED INTERACTIONS OF NEIGHBOUR IONS AND SYMMETRY PROPERTIES OF TITRATION CURVES IN POLYELECTROLYTES. See Abstr. 8622

541.135.5

9163. ELECTROCHEMICAL BEHAVIOR OF THE PALLADIUM–HYDROGEN SYSTEM. I. POTENTIAL-DETERMINING MECHANISMS. S.Schuldiner, G.W.Castellan and J.P.Hoare.
J. chem. Phys., Vol. 28, No. 1, 16-19 (Jan., 1958).

The potential of saturated α-palladium in hydrogen-stirred solution compared to a Pt/H_2 electrode in the same solution is 0.0495 ± 0.0005 V. The potential-determining reaction on α-palladium is independent of hydrogen pressure. The potential-determining equilibrium is postulated to be, $H^+ + e \overset{Pd}{=} (Pd{-}H)_\alpha$. Pure palladium spontaneously absorbs hydrogen in hydrogen-stirred solution until the saturation limit of the α phase is reached. This limiting atomic ratio of H/Pd = 0.025 ± 0.005. Between a H/Pd atomic ratio of 0.03 to 0.36 both the α and β phase coexist and the mixed potential is determined by that of the α domains. In the H/Pd region 0.36 to 0.6, the potential is a function of the hydrogen content of the palladium. A.

541.135.5

9164. ELECTROCHEMICAL BEHAVIOR OF THE PALLADIUM–HYDROGEN SYSTEM. II. THERMODYNAMIC CONSIDERATIONS. G.W.Castellan, J.P.Hoare and S.Schuldiner.
J. chem. Phys., Vol. 28, No. 1, 20-1 (Jan., 1958).

The thermodynamic relationships between the potentials of the palladium–hydrogen alloys and the known equilibrium properties of the system, palladium–hydrogen gas, are derived and discussed. A value of 0.048 V for the potential of the saturated α alloy derived from the gas phase data is in substantial agreement with the observed value of 0.050 V. The spontaneous loss of hydrogen from the electrolytically charged alloy of composition, H/Pd ~ 0.6, to form an alloy of lower hydrogen content shows that there is an unusual free-energy situation involved in this system. This is discussed and an explanation of the free energy scheme is suggested. A.

541.135.5

9165. ELECTROCHEMICAL BEHAVIOR OF THE PALLADIUM–HYDROGEN SYSTEM. III. GAS-CHARGED PALLADIUM ALLOYS. J.P.Hoare, S.Schuldiner and G.W.Castellan.
J. chem. Phys., Vol. 28, No. 1, 22-4 (Jan., 1958).

Experimental evidence is presented to support the proposed difference in electrochemical properties of the β- and β'-palladium–hydrogen alloys. It is shown that the β-palladium–hydrogen electrode is a true equilibrium hydrogen electrode. A consideration of the electrocapillary properties of pure palladium and the α-palladium alloys in solution provides an explanation of the cessation of spontaneous absorption of hydrogen before complete equilibrium is attained. A.

541.135.5

9166. RECALCULATION OF THE LATIMER, PITZER, AND SLANSKY ABSOLUTE ELECTRODE POTENTIAL — A DISCUSSION OF ITS OPERATIONAL SIGNIFICANCE. A.J.deBethune.
J. chem. Phys., Vol. 29, No. 3, 616-25 (Sept., 1958).

The Latimer, Pitzer, and Slansky (L.P.S) calculation of the absolute electrode potential of the standard calomel electrode (StdCE) involves a sequence of processes in which the metals Hg and Na appear. Let Hg be the "first" metal and Na the "second" metal. The substitution of 21 other metals M for Na as the second leads to an array of remarkably self-consistent values. With 16 uni- and divalent second metals M, the L.P.S. potential of the StdCE falls in the range of +0.523 to +0.693 V (with the Gibbs–Stockholm sign convention) with a mean of +0.599 V and a standard deviation of 0.043 V. The constancy of these values is shown to be thermodynamically reasonable. The L.P.S. method is then generalized to obtain the absolute electrode potentials of 22 other standard electrodes (SMeE) by substituting 22 other "first" metals Me for Hg. The generalized L.P.S. absolute potentials of the 22 SMeE's can be converted to that of the StdCE by (1) a simplest, (2) a more refined calculation procedure. The simplest generalized L.P.S. potential of the StdCE is strongly dependent on the choice of the first metal Me, the more refined potential is independent of this choice and agrees with the values obtained above with Hg as first metal. A conceptual experiment is set up by which it is shown that the L.P.S. potential or any of the generalized L.P.S. potentials of the StdCE can be interpreted operationally as linear combinations of conceptually observable potentials differences, all potentials being taken in "pieces of the same kind of metal" (to use Gibbs' phrase). This experiment suggests that the L.P.S. potential of the StdCE is equivalent to the measurable outer or volta potential difference in a free space gap between mercury and electrolyte, when the two phases are in electrical contact. The discrepancy between the L.P.S. calculated value and Klein and Lange's experimental value for this volta potential difference is discussed, and an experimental value of −98.3 kcal obtained for the standard free energy of hydration of the sodium ion. A.

PHOTOCHEMISTRY. RADIATION CHEMISTRY

541.14

9167. MERCURY PHOTOSENSITIZED POLYMERIZATION OF ACETYLENE. S.Shida, Z.Kuri and T.Furuoya.
J. chem. Phys., Vol. 28, No. 1, 131-5 (Jan., 1958).

Benzene was found in the reaction products in addition to polymer and hydrogen. Effect of acetylene pressure and light intensity on the rate, effect of pressure on the formation of hydrogen and benzene, and effect of temperature on the rate of benzene formation were studied. The fraction of acetylene reacting to form benzene was constant at 0.29 in the range of the acetylene pressure studied. The quantum yield of the over-all reaction was 4.8 including the yield of benzene and 4.3 excluding it. The reaction mechanism is discussed. A.

541.14

9168. REACTIONS OF ALKOXY RADICALS. IV. PHOTOLYSIS OF METHYL-d_3 ACETATE AT HIGH TEMPERATURES. M.H.J.Wijnen.
J. chem. Phys., Vol. 28, No. 5, 939-43 (May, 1958).

For Pt III see Abstr. 1362 (1958). The photolysis of CH_3COOCD_3 was investigated over the temperature range 145 to 350° C at varying initial pressures and light intensities. The following reactions were studied in detail:

$$CD_3O + CH_3 \rightarrow CH_3D + CD_2O, \quad (7)$$

$$CD_3O + CH_3 \rightarrow CH_3OCD_3, \quad (6)$$

$$CD_3O + CH_3COOCD_3 \rightarrow CD_3OH + CH_2COOCD_3, \quad (16)$$

$$CH_3 + CH_3COOCD_3 \rightarrow CH_4 + CH_2COOCD_3. \quad (12)$$

A value of about 1.4 is obtained for k_7/k_6. The results indicate that the activation energy of reaction (7) is zero kcal. A value of 10 ± 0.5 kcal is obtained for E_{12}, while the data indicate a value of approximately 5 kcal for E_{16}. A.

541.15

9169. HYDROGEN CONVERSION AND EXCHANGE REACTIONS IN AQUEOUS SOLUTIONS INDUCED BY GAMMA RAYS. H.L.Friedman and A.H.Zeltmann.
J. chem. Phys., Vol. 28, No. 5, 878-90 (May, 1958).

Experimental studies were made of several γ-ray-induced reactions of hydrogen in aqueous solutions in which no net chemical change occurs. The most complete results were obtained at pH 2, where radiation-induced chain reactions are found in the conversion of parahydrogen and in the isotope exchange reactions of HD and of H_2–D_2 mixtures, but where there is only a nonchain exchange of D_2 with the solvent. The exchange data are in agreement with the earlier work of Gordon and Hart, but are more extensive in some respects. It is assumed that the chain conversion and exchange are carried by steps such as

$$H + H_2 \rightarrow H_2 + H,$$

$$H + D_2 \rightarrow HD + D,$$

and isotopically related reactions, and furthermore that these reactions have the same specific rate constants in solution as in the gas phase at the same temperature. All the data at pH 2 can then be correlated by a single mechanism and the following conclusions are reached. At the lower dose rates in solutions of H_2 the effective stationary-state concentration of H atoms is proportional to the dose rate, reaching 2×10^{-8} M at 10^{15} eV/l.sec. The effective mean life of H atoms under these conditions is 0.2 sec. The rate constant of the reaction $H + H \rightarrow H_2$, in water at pH 2 is at most 1×10^8 l/mole sec. The pseudo first-order rate constant of the reaction $D + H_2O \rightarrow DOH + H$, in water at pH = 2 is 2 sec^{-1}. The last conclusion leads to an important restriction on the importance of H_2^+ in irradiated solutions, namely, H_2^+ cannot be in rapid equilibrium with H and H^+ or this would be a path for a fast exchange of D with H_2O. The investigation of other pH ranges is less complete than that at pH 2, but the conclusion of Gordon and Hart, that the stationary-state H atom concentration produced by γ-rays is much lower in basic than in acid solution, is confirmed. A.

541.15 : 539.17

9170. CHEMICAL EFFECTS OF PHOTONUCLEAR REACTIONS IN THE PROPYL BROMIDES. A.E.Richardson and A.F.Voigt.
J. chem. Phys., Vol. 28, No. 5, 854-63 (May, 1958).

Two new photonuclear reactions are reported, $Br^{79}(\gamma,2n)Br^{77}$ and $Br^{79}(\gamma,3n)Br^{76}$. The organic retention following the $Br^{81}(\gamma,n)Br^{80}$ reaction in liquid n- and isopropyl bromides was found to be 47 and 36%, respectively, appreciably higher than reported values following the $Br^{79}(n,\gamma)Br^{80m}$ reaction. Higher retentions were also noted for irradiations of the solid bromides. The relative yields of individual organic products were determined for irradiations of both liquid and solid and were in many respects in striking agreement with data from activation by (n,γ) reaction and isomeric transition. In solid n-propyl bromide the (γ,n) and $(\gamma,3n)$ reactions gave the same ratio of parent compound to total organic yield. Data on the scavenger effect show that thermal recombination reactions occur in both liquid and solid. Marked increases are shown in the thermal organic yield with only slight increases in the nonthermal retention for both bromides for (γ,n) compared to (n,γ) activation. The reasons for these increases are discussed. In general, the data indicate that elastic collision mechanisms are unimportant compared to random fragmentation as an explanation of the results. A.

DISPERSIONS. COLLOIDS. ADSORPTION

541.183

9171. ENERGY EXCHANGE BETWEEN COLD GAS MOLECULES AND A HOT GRAPHITE SURFACE. L.Meyer and R.Gomer.
J. chem. Phys., Vol. 28, No. 4, 617-22 (April, 1958).

Methane or ethane do not decompose on clean graphite surfaces up to 2300° C as long as the mean free path of the gas molecules exceeds the dimensions of the reaction cell. An investigation of the energy exchange between a hot graphite surface and cold molecules impinging on it revealed an accommodation mechanism of temporary adsorption followed by evaporation at critical temperatures essentially independent of the filament temperature as long as the latter is higher than the former. The evaporation temperature for methane is far below its decomposition temperature. A.

541.183 : 537.312.5

9172. PHOTODESORPTION IN ZINC OXIDE SEMICONDUCTOR. D.B.Medved.
J. chem. Phys., Vol. 28, No. 5, 870-3 (May, 1958).

Dark and photoconductivity in sintered zinc oxide have been studied by Morrison and Melnick as an oxygen chemisorption process. An order of magnitude calculation shows that a consequence of Melnick's theory of photoconductivity should be an observable new effect which is called photodesorption (the release of surface adsorbed gases by light). Measurement of the photodesorption from sintered porous zinc oxide simultaneously with the photoconductivity is described. A.

541.183 : 533.15

9173. DIFFUSION AND HETEROGENEOUS REACTION. I. THE DYNAMICS OF RADICAL REACTIONS. H.Wise and C.M.Ablow.
J. chem. Phys., Vol. 29, No. 3, 634-9 (Sept., 1958).

The diffusion and heterogeneous reaction of labile species in a cylinder of finite length are examined. The effects of radial and longitudinal diffusion are included in the mathematical treatment. The results of this analysis are applied to published data of the recombination coefficients of oxygen and hydrogen atoms on the surfaces of various materials. A.

541.183

9174. APPARATUS FOR THE DIRECT MEASUREMENT OF ADSORPTION ON SOLID SURFACES FROM LIQUIDS. J.A.Kafalas and H.C.Gatos.
Rev. sci. Instrum., Vol. 29, No. 1, 47-50 (Jan., 1958).

The apparatus is for the measurement in situ of adsorption of solutes on solids and of the kinetics of film formation on solid surfaces. The technique is applicable only to very dilute solutions in which the solute can be tagged with a γ- or hard β-emitting isotope. The adsorbed radioactivity of the surface is determined through a continuously replenished thin layer of solution. The kinetics and equilibrium conditions of adsorption, desorption and exchange reactions can be determined conveniently; simultaneously, the electrochemical behaviour of the surface can be studied. Some measurements are reported. A.

CHEMICAL ANALYSIS

545.8 : 538.221

9175. MAGNETIC ANALYSIS OF THE URANIUM–OXYGEN SYSTEM. A.Arrott and J.E.Goldman.
Phys. Rev., Vol. 108, No. 4, 948-53 (Nov. 15, 1957).

Magnetic susceptibility measurements were carried out on the uranium–oxygen system in the composition range of UO_2 to $UO_{2.67}$. The existence of an antiferromagnetic transition at compositions close to stoichiometric UO_2 was confirmed. The data make it possible to define clearly the phase limits of the UO_2 and U_3O_8 structures and to determine unambiguously that the excess oxygen ions in the non-stoichiometric salts occupy interstitial positions in the lattice. A.

CRYSTALLOGRAPHY

548.2

9176. DEVELOPMENT OF PREFERRED ORIENTATIONS IN SILICON IRON. J.R.Brown.
J. appl. Phys., Vol. 29, No. 3, 359-60 (March, 1958).

The (110) [001] texture in silicon iron arises by a process of secondary recrystallization after cold reduction of the strip in two stages separated by an anneal. It is possible to produce the same texture by a one-stage or a three-stage reduction process. The rolling textures and primary recrystallization textures for each of these processes were experimentally determined and are all different. In spite of this, the (110) [001] secondary orientation develops in each case. It is tentatively suggested that impurities in the steel, already known to be important in controlling grain growth in silicon iron, also supply the directional forces leading to the (110) [001] texture. A.

548.2

9177. (110) [001] SECONDARY RECRYSTALLIZATION TEXTURE IN THREE PERCENT SILICON–IRON. H.C.Fiedler.
J. appl. Phys., Vol. 29, No. 3, 361-2 (March, 1958).

The secondary recrystallization texture has been related to the structure developed during prior processing. The (110) [001] component of the primary recrystallization texture, from which secondary grains grow, develops from the (111) <112> doublet component in the prior recrystallization texture. If the material undergoes two rather than one prior recrystallization heat treatments (each separated by a cold reduction), the amount of the (110) [001] component in the primary recrystallization texture is in general increased, and as a concequence, the completeness of secondary recrystallization is promoted. A.

548.5

9178. FILAMENTARY GROWTH IN IRRADIATED URANIUM. W.M.Barss, Z.S.Basinski and F.R.N.Nabarro.
Canad. J. Phys., Vol. 36, No. 7, 980-3 (July, 1958).

Radiographs are shown of long filaments which grew on a fractured uranium bar in the N.R.X. reactor. Reasons are discussed for believing that the purely thermal and mechanical conditions in the fuel element will not account for such long whiskers, but that the vacancies or interstitial atoms produced by irradiation may stimulate an adequate rate of whisker growth. J.Adam

548.5 : 539.2

9179. THE GROWTH AND COALESCENCE OF CRYSTALS UNDER THE INFLUENCE OF IONIZING RADIATIONS. M.L.Baskin and A.A.Semerchan.
Vestnik Akad. Nauk SSSR, Vol. 28, No. 1, 69-70 (1958). In Russian.

It is claimed that intense irradiation by ~ 1 MeV electrons (or ions or X-rays) can bring about the recrystallization of crystalline solids at (or near) room temperature. A brief description is given of the formation of crystals of alumina from aluminium metal electron-irradiated in the presence of oxygen (total exposure ~ 8 μA hour per mm^3). The effect is interpreted in terms of enhancement of diffusion rates on irradiation. The possible preparation of single crystals of alumina of high perfection is suggested. C.H.L.Goodman

548.52 : 539.2

PRODUCTION OF DISLOCATIONS DURING GROWTH FROM THE MELT. See Abstr. 9120

548.522

9180. CRYSTAL GROWTH MECHANISM IN CADMIUM SULFIDE CRYSTALS. D.C.Reynolds and L.C.Greene.
J. appl. Phys., Vol. 29, No. 3, 559-62 (March, 1958).

Large cadmium sulphide crystals were grown from the vapour phase. The crystal growth was studied by observing growth patterns, chemical etch patterns, and vaporization patterns. The studies reveal a layer or lamellar type growth, the layers resulting from the coalescence of monoatomic steps into ledges of many atomic layers in height. The layers are generated at or near the crystal edge and move across the surface by edge nucleation. The exact mechanism by which the steps are generated is not known, however, it is believed that they result from screw dislocations or surface nucleation. A.

X-RAY CRYSTALLOGRAPHY

548.73/.74

X-RAY AND ELECTRON INVESTIGATION OF MATERIALS. See also under "Structure of solids". Decimal classification 539.26/.27

548.732

9181. X-RAY SCATTERING NEAR CRITICAL AND ISOLATED POINTS OF A SECOND-ORDER PHASE TRANSITION.
M.O.Krÿvohlaz.
Ukrayin. fiz. Zh., Vol. 2, No. 2, 114-21 (1957). In Ukrainian, with summaries (1½ pp.) in Russian and (½ p.) in English.

The thermodynamic theory of second-order phase transitions is employed for considering monochromatic X-ray scattering from a single crystal near these points. Anomalous high diffuse scattering is encountered near the superlattice line. For given incidence and scattering angles the background X-ray intensity varies continuously with temperature, being a maximum at the transition temperature and decreasing linearly on either side. Unusually large diffuse scattering also occurs near an isolated point of the second-order phase transitions. C.R.S.Manders

548.736 : 538.221

CRYSTALLOGRAPHIC PROPERTIES OF SUBSTITUTED YTTRIUM–IRON GARNET. See Abstr. 8913

548.736.

9182. LAYER STRUCTURES OF MAGNETIC OXIDES. S.Iida.
J. Phys. Soc. Japan, Vol. 12, No. 3, 222-33 (March, 1957).

In most of the ferromagnetic oxides, the anion lattices are constructed by piling up two-dimensional trigonal lattice layers in succession. Metallic ions locate on the proper interstices of these anion layers, themselves forming also several kinds of layers. It was shown that the crystal lattices of these oxides can be constructed uniquely by assuming: (1) the layer structures outlined above, (2) requirement of minimizing the sum of electrostatic energy and interionic repulsive energy and (3) that the numbers of cations locating between two neighbouring anion layers are all the same. From this consideration, 13 M–O–M configurations are derived as possible configurations for the superexchange interaction in magnetic oxides. It is shown that the magnetic lattices also have layer structures. A.

548.74 : 538.221

NEUTRON DIFFRACTION INVESTIGATION OF THE 119°K TRANSITION IN MAGNETITE. See Abstr. 8914

GEOPHYSICS

550.38 : 532.5 : 538.3

A CLASS OF SELF-SUSTAINING DISSIPATIVE SPHERICAL DYNAMOS. See Abstr. 8934

551.46 : 534.874 : 534.232

AMBIENT NOISE IN THE OCEAN. See Abstr. 8657

551.481.18 : 534.24

9183. ACOUSTIC CHARACTERISTICS OF A LAKE BOTTOM.
J.L.Jones, C.B.Leslie and L.E.Barton.
J. Acoust. Soc. Amer., Vol. 30, No. 2, 142-5 (Feb., 1958).

Standing-wave measurements are discussed which show that the bottom of a fresh-water lake near Washington, D.C. behaves acoustically as a pressure-release surface between 50 and 500 c/s. A correlation technique is presented which makes it possible to distinguish between the part of an acoustic signal which arrives by a direct path and the part which experiences a bottom reflection. Results of a study of the acoustic behaviour of the lake bottom by this method confirm the conclusions reached from the standing-wave measurements for frequencies up to 1600 c/s. Correlation and transient measurements of the acoustic velocity in the bottom sediment are presented which indicate that the pressure-release characteristics result from an acoustic velocity in the bottom of less than one-tenth that of water. This low velocity is attributed to the presence of gas resulting from decaying organic matter in the bottom. The gas greatly increases the bulk compressibility of the bottom sediment and hence lowers the sound velocity. A.

ATMOSPHERE. METEOROLOGY

551.508.2 : 536.33.08

APPARENT TEMPERATURES OF SOME TERRESTRIAL MATERIALS AND THE SUN AT 4.3 MILLIMETRE WAVELENGTHS. See Abstr. 8725

551.508.25 : 536.33.08 : 538.563 : 621.317.39

9184. CAPACITOR MICROPHONE AS A RADIATION DETECTOR.
M.L.Harbold and J.L.Bohn.
Rev. sci. Instrum., Vol. 29, No. 3, 229-32 (March, 1958).

A description is given of how a capacitor microphone acts as the variable capacitance to modulate the frequency in the tank circuit of a f.m. transmitter. When chopped light falls on the capacitor microphone, the capacitance of the microphone fluctuates at the same frequency as the chopping frequency. This effect is analysed, and it is shown that absorption of the incident electromagnetic radiation sets up a temperature gradient across the thickness of the front electrode. As a result of this, the front of the electrode (the part facing the radiation source) expands toward the source, and causes a change in the distance between the electrodes of the capacitor and thus varies the capacitance of the microphone. The instrument, which responds to a wide range of frequencies and to a very large dynamic range of intensity, is quite rugged. It has an additional advantage in being its own telemetering device. A.

551.510.3

9185. HIGH ATMOSPHERE DENSITIES. M.Nicolet.
Science, Vol. 127, 1317-20 (June 6, 1958).

It is shown that values of air density $> 10^{-18}$ g/cm^3 at heights ~ 500 km, such as are indicated from observations of artificial earth-satellites, can only be reconciled by postulating temperatures much higher than those associated with classical upper-atmosphere models, i.e. ~ 1500°K. Similar high values of temperature are also required to explain the escape time of atmospheric He ($\sim 2 \times 10^8$ yr). The concept of a constant concentration ratio,

$$\{n(O) + 2n(O_2)\}/\{n(N) + 2n(N_2)\} \approx 1/4,$$

is incompatible with such high temperatures and, to overcome the difficulty, some diffusion mechanism is introduced. Chapman's theory (1956-57) of inward solar heat flow due to the earthward extension of the corona yields an heat-transport process that can satisfactorily account for the observed high temperature of the atmosphere around 500 km. D.R.Barber

551.510.535

RADIO-WAVE PROPAGATION IN THE IONOSPHERE. See also under "Electromagnetic waves and oscillations". Decimal classification 538.566.3

551.574.1

9186. THE PRODUCTION OF CONDENSATION NUCLEI BY CRYSTALLIZING SALT PARTICLES.
S.Twomey and K.N.McMaster.
Tellus, Vol. 7, No. 4, 458-61 (Nov., 1955).

Experiments were conducted to examine the possibility of condensation nuclei being produced by salt droplets when the environmental humidity was lowered sufficiently for crystallization to take place. It was found that condensation nuclei were in fact produced when salt particles crystallized, each salt particle producing at least several hundred nuclei. It is suggested that these nuclei consisted of minute salt crystals, with mass in the range from 10^{-16} to 10^{-14}g, released from the main mass of salt during crystallization. A.

551.594.5

9187. A COMPARISON OF RADIO ECHOES FROM THE AURORA AUSTRALIS AND AURORA BOREALIS.
D.P.Harrison and C.D.Watkins.
Nature (London), Vol. 181, 43-4 (July 12, 1958).

Continuous records of radio-echoes from A. Australis, made since May 1957 at Halley Bay, Antarctica, are compared with concurrent observations of A. Borealis made at Jodrell Bank, England as part of the I.G.Y. auroral programme. For the period, May-October 1957, a very marked positive correlation exists between the number of hourly intervals per day of auroral echoes recorded at Halley Bay and the daily sum of the planetary geomagnetic index, K_p. Because of the differing situations of northern and southern stations relative to the respective zones of maximum auroral activity echoes were recorded at Halley Bay during 26% of the total observing time compared with only 2% at Jodrell Bank. Only the most

active types of A. Borealis accompanying a moderate or great magnetic storms gave echoes at the northern station, although in each instance these events coincided with marked peaks of echo activity at Halley Bay. Thus the great aurorae of the N. hemisphere are accompanied by simultaneous enhancement of auroral activity in the S. hemisphere. D.R.Barber

BIOLOGY

578.087.8 : 538.082.103

MAGNETIC SUSCEPTOMETER FOR THE STUDY OF RAPID BIOCHEMICAL REACTIONS. See Abstr. 8857

591.485 : 599.742.77

9188. SYNCHRONY OF NEURAL ACTIVITY IN ELECTRIC RESPONSES EVOKED BY TRANSIENT ACOUSTIC STIMULI. M.H.Goldstein, Jr and N.Y.-S.Kiang.
J. Acoust. Soc. Amer., Vol. 30, No. 2, 107-14 (Feb., 1958).

Electric responses evoked by transient acoustic stimuli were recorded by gross electrodes from the periphery and cortex of the cat. The responses to clicks and to the rapid onset of bursts of noise or tones are characterized by a sharp N_1 peak in the peripheral response and by a broader cortical response. When the rise time of the onset of bursts of noise (or tones) is lengthened, or when a burst of sudden onset is presented in a noise background, it is possible to obtain cortical responses under conditions for which the N_1 component of the peripheral response is undetectable. These results and associated findings are interpreted by considering the degree of synchronization of the discharge and the wave-forms of the activity of units that contribute to responses recorded by gross electrodes. A simple statistical interpretation is presented. A.

MEDICAL SCIENCE. HUMAN PHYSIOLOGY

611.73

9189. DEVICE FOR MEASURING ISOTONIC OR ISOMETRIC CONTRACTIONS OF HEART MUSCLE. W.J.Whalen and O.Weddle.
Rev. sci. Instrum., Vol. 29, No. 2, 144-5 (Feb., 1958).

The device converts the motion of isotonic contraction into an electrical signal which can be recorded with the same equipment used to record the output of an isometric strain gauge. The isotonic gauge is essentially a straight wire potentiometer which moves freely through mercury contacts. The muscle is attached to one end of a lever and the resistance wire with a suitable weight (usually 0.5 g) attached to the other end. As shortening of the muscle occurs the resistance between the mercury contacts increases. Changes in length of about 0.1 mm can be quite accurately recorded. Turning a screw attached to a strain gauge down on the lever registers the isometric force in the conventional manner. The whole system is mounted on a movable stage. A.

612.843.31

9190. QUANTITATIVE EVALUATION OF COLOR PERCEPTION: AN HYPOTHESIS. E.H.De Kleine.
J. Opt. Soc. Amer., Vol. 48, No. 10, 722-5 (Oct., 1958).

Characteristics of other photochemical processes are cited, which might also pertain to those of the retina. By assuming such relationships for retinal receptors, hypothetical formulae are derived for conversion of tristimulus (C.I.E.) values to physiological terms presumed to represent colour perception. Substantial agreement between these physiological functions and actual observer response (ideal Munsell system) indicates a close degree of correlation. This approach is suggested as a basis for studying the problem of balanced perceptual colour spacing. A.

612.843.611

9191. DIFFERENCE LIMEN AS A FUNCTION OF RETINAL ECCENTRICITY AND BACKGROUND BRIGHTNESS. P.M.Blough.
J. Opt. Soc. Amer., Vol.48 , No. 10, 731-5 (Oct., 1958).

Earlier work has dealt with the effect of adaptation level and pre-exposure brightness upon the course of foveal dark adaptation. One of the studies used the difference limen as the measure of sensitivity, and the findings included a function relating the foveal difference limen (ΔB) to background brightness. The goal of this experiment was to obtain difference limens at several combinations of background brightness and retinal eccentricity. Background brightnesses were 0.0001, 0.001, 0.01, 0.1, 1, and 10 ft lm; retinal locations were the fovea and 2^0, 6^0, and 10^0 in the nasal portion. Monocular difference limens were determined using a 1^0 test stimulus superimposed at the centre of a 27^0 background. The technique of threshold determination was the ascending series of the method of limits. The findings suggest that the curve describing log ΔB v. log background brightness becomes steeper as retinal eccentricity increases. At the three higher background brightnesses log ΔB increased as a function of eccentricity; at the three lower brightnesses log ΔB decreased with increasing eccentricity. In both cases the curves were negatively accelerated. It is suggested that the rising functions represent cone and the falling ones, rod thresholds. It appeared that the slopes of the curves relating ΔB to eccentricity were not as great at intermediate background brightnesses as they were at extreme values. This finding suggests a gradual rather than a sudden transition from rod to cone activity as brightness increases. A.

612.843.63

9192. BRIGHTNESS AND VISUAL ACUITY WITH INTERMITTENT ILLUMINATION. J.Nachmias.
J. Opt. Soc. Amer., Vol. 48, No. 10, 726-30 (Oct., 1958).

Data on perceived brightness and visual acuity were obtained under essentially identical conditions of steady and intermittent illumination, using long exposures (up to 45 sec) as well as brief ones (250 msec). Flicker frequencies down to 8 c/s and light-time fraction to 0.083 were sampled. By taking into account the exact duration of the test exposures, a more general form of Talbot's law was derived, which fits all the brightness matches obtained. When this new equation is used as a yardstick, intermittent illumination turns out to be less efficient than steady illumination so far as visual acuity is concerned for brief exposures. For long exposures it is more efficient, as was previously reported by Senders (Journal of Experimental Psychology, Vol. 37, 453-65, 1949). A.

612.843.63 : 621.397.621

9193. THE RECOGNIZABILITY OF IMAGE DETAIL IN TELEVISION PICTURES. W.Kroebel, F.Arp and H.Baurmeister.
Z. angew. Phys., Vol. 10, No. 7, 320-7 (July, 1958). In German.

Continuation of earlier work by the authors on quantitative estimation of recognizability. Circular dark objects on a light background are used with different viewing distances. A linear relation between contrast and recognizability is found. Comparison is made with results on optically projected images. B.Meltzer

612.85

9194. STANDARDIZED COMMUNICATIONS AND MESSAGE RECEPTION. I.Pollack and J.Tecce.
J. Acoust. Soc. Amer., Vol. 30, No. 1, 62-4 (Jan., 1958).

The reproduction of messages, selected from defined information sources, was studied in a multichannel listening task. Standardization of message procedures was controlled independently of standardization of message nomenclature. It is shown that the standardization of procedures or nomenclature is an effective determinant of message reproduction. And, the joint standardization of both nomenclature and procedure is more effective than either alone. A.

612.85

9195. MESSAGE PROCEDURES FOR UNFAVORABLE COMMUNICATION CONDITIONS. I.Pollack.
J. Acoust. Soc. Amer., Vol. 30, No. 3, 196-201 (March, 1958).

Several message procedures, designed to improve speech communications under extremely unfavourable speech-to-noise ratios, were examined. A message procedure based upon the informational principle of successive selections among a reduced number of alternatives was strikingly superior to a message procedure based upon the repetition of a single selection among a larger number of alternatives. Information, alone, is not the entire story because message diversity, without change of information, may produce nearly equivalent results. A.

612.85

9196. CONFIDENCE RATINGS, MESSAGE RECEPTION, AND THE RECEIVER OPERATING CHARACTERISTIC.
I.Pollack and L.R.Decker.
J. Acoust. Soc. Amer., Vol. 30, No. 4, 286-92 (April, 1958).

A rating scale was added to the standard articulation test procedure in order to obtain independent information about a listener's criterion for message acceptance or rejection. It is found that assignment of confidence ratings does not interfere with the accuracy of message reception. The form of the receiver operating characteristic — the relationship between correct confirmations and false alarms — yielded by the rating procedure is similar to that yielded by a binary decision of message acceptance or rejection. In addition, the confidence rating is directly related to the average accuracy of message reception. This relationship is relatively invariant over a range of speech-to-noise ratios. A.

TECHNIQUE. MATERIALS

66.04 : 621.365.2

9197. CARBON ARC IMAGE FURNACES.
M.R.Null and W.W.Lozier.
Rev. sci. Instrum., Vol. 29, No. 2, 163-70 (Feb., 1958).

Various optical systems are discussed with reference to their use with carbon arc image furnaces. A new optical system which employs two elliptical mirrors is described and shown to have numerous practical advantages. Using modifications of motion picture projection lamps, measurements were made of carbon arc image furnaces ranging up to more than 26 kW power input, producing approximately 3 kW radiant flux at the image within a circular area of 30 mm diameter, with a centre of image irradiance as high as 15 W/mm^2, a flux density equivalent to the radiation from a blackbody at more than 4000° K. Furnaces of lower output and higher efficiency are also described. Comparison with available data indicates carbon arc image furnace performance is essentially equivalent to existing solar furnaces in the 60 to 100 in. diameter range. Possibilities for further improvement of carbon arc image furnaces are also considered. A.

669 : 538.22

9198. MAGNETOMETALLURGY — APPLICATIONS AND TECHNIQUES. A.Arrott.
J. appl. Phys., Vol. 29, No. 3, 508-12 (March, 1958).

The use of measurements of intrinsic magnetic properties — susceptibility, saturation magnetization, and transition temperature — in solving problems in metallurgy is discussed. Applications to phase-diagram determinations, precipitation studies, kinetics, detection of inhomogeneities, and quantitative analysis are considered. A.

669.09 : 537.311.33

9199. PREPARATION OF LARGE-AREA P–N JUNCTIONS [MONOCRYSTALLINE] SILICON BY SURFACE MELTING.
E.Billig and D.B.Gasson.
J. appl. Phys., Vol. 28, No. 11, 1242-5 (Nov., 1957).

Two methods were developed, using surface melting and overdoping of the molten material. In one method, direct r.f. power coupling is used to form a cylindrical p–n junction in a rod of silicon. Also, radiation heating was used to melt the surface of thin disks of silicon. The junctions can sustain a peak inverse voltage (P.I.V.) given approximately by P.I.V. = $40\rho_n$ or P.I.V. = $10\rho_p$ depending on the polarity of the base material, of resistivity ρ_n or ρ_p. Low-resistivity n-type base material overdoped with aluminium forms junctions exhibiting very sharp breakdown characteristics, and P.I.V. = $40\rho_n$ holds for material at least up to 15 ohm cm. Some results obtained by using a gas doping technique are also given. A.

669.09

9200. PULSE-ANNEALING TECHNIQUE FOR METALS AND ALLOYS. P.Wright and K.Thomas.
Brit. J. appl. Phys., Vol. 9, No. 8, 330-3 (Aug., 1958).

An account is given of some improvements in the technique of pulse annealing. Procedures for sharpening up the pulsing and quenching processes, and for accurately controlling the annealing temperature, are described. Some experimental results on Cu$_3$Au are given to illustrate the special uses of the pulse-annealing method. A.

PHOTOGRAPHY

771.531 : 539.27

THE PROPERTIES OF PHOTOGRAPHIC EMULSIONS UNDER ELECTRON IRRADIATION. See Abstr. 8479

778.31 : 535.81 : 532.613.4

MICROCINEMATOGRAPHY OF DYNACTIVE PAIRS OF FLUIDS. See Abstr. 8611

778.33 : 534.222.2

APPARATUS FOR PRECISION FLASH RADIOGRAPHY OF SHOCK AND DETONATION WAVES IN GASES. See Abstr. 8647

778.34

9201. A NUCLEAR PLATE CAMERA FOR ANGULAR DISTRIBUTION MEASUREMENTS WITH GASEOUS OR SOLID TARGETS OVER A WIDE RANGE OF ANGLES.
W.M.Jones and D.G.Waters.
J. sci. Instrum., Vol. 35, No. 8, 286-8 (Aug., 1958).

The instrument was checked by comparing the angular distributions of deuterons elastically scattered from gold and xenon targets, with the Rutherford scattering-law down to 8° in the forward direction. A.

778.34 : 535.376 : 539.12

PARTICLE RESOLVING POWER OF PHOTOGRAPHIC PLATES. See Abstr. 8196

LIST OF JOURNALS

The following list supplements the List of Journals published with the June number of Volume 60 (1957) and the Supplement published with the Index to the same volume. Reprints of the List of Journals and of the Supplement can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

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ERRATA

Abstr. 1212 (1958) line 3 : for "P.Woloschek" read "P.Waloschek".
Abstr. 6055-6 (1958) line 3 : for "N.Van Dang" read "Nguyen Van Dang".
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Abstr. 7506 (1958) line 2 : for "W.J.Johnston" read "W.G.Johnston".

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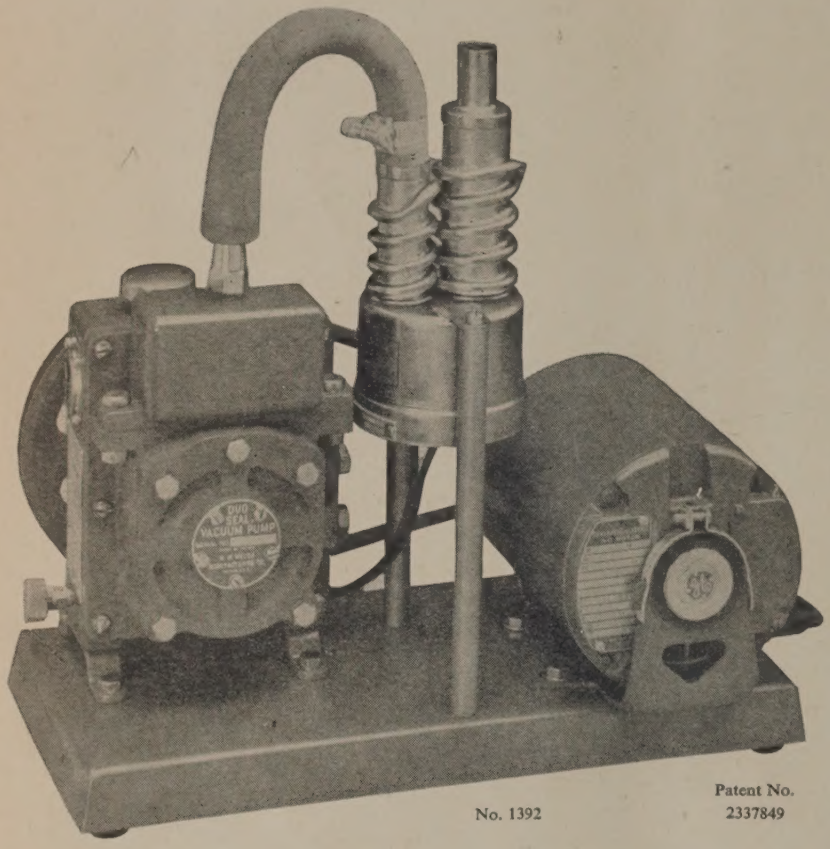

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